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ANNUAL ABSOLUTE HUMIDITY PROBABILITIES FOR SELECTED MARINE LOCA--ETC(U)
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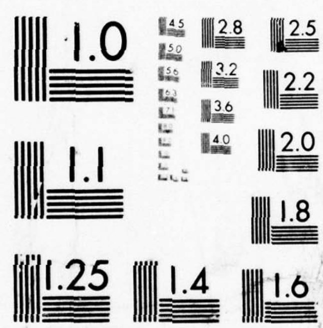


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# ANNUAL ABSOLUTE HUMIDITY PROBABILITIES FOR SELECTED MARINE LOCATIONS

Paul M. Moser
Aero Electronic Technology Department
NAVAL AIR DEVELOPMENT CENTER
Warminster, Pennsylvania 18974



24 February 1973

TECHNICAL MEMORANDUM
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

In a previous technical memorandum "Mathematical Model of FLIR Performance" of 19 Oct 1972, a set of equations was developed which permits one to calculate acquisition, classification and identification ranges for ship targets when viewed by an airborne forward looking infrared (FLIR) imaging device. In performing such calculations, one of the crucial factors is the attentuation by the intervening atmosphere of the infrared radiation emitted by the target and received by the sensor. Atmospheric water vapor, whose concentration is quite variable over time and place, is a principal absorber of



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infrared radiation over the spectral range of interest. ~~This technical memorandum~~ The present report provides, in the forms of histograms and graphs, percent frequencies of occurrence and cumulative percent frequencies of occurrence, respectively, of the various concentrations of atmospheric water vapor for each of ~~twenty-one~~ 21 maritime sites throughout the northern hemisphere over the entire year. Similar data representing a composite over all ~~twenty-one~~ 21 sites are also given. These data serve as inputs to the mathematical model.



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NAVAL AIR DEVELOPMENT CENTER
AERO ELECTRONIC TECHNOLOGY DEPARTMENT
WARMINSTER, PENNSYLVANIA 18974

24 Feb 1973

TECHNICAL MEMORANDUM NADC-20203:PMM

Subject: Annual Absolute Humidity Probabilities for Selected Marine Locations

References: (a) AIRTASK A360360C/001B/3F32343604
(b) NAVAIRDEVCEN Tech Memo NADC-20203:GBL/PMM, "Monthly Absolute Humidity Probabilities for Selected Marine Locations" of 28 Dec 1972
(c) NAVAIRDEVCEN Tech Memo NADC-20203:PMM, "Mathematical Model of FLIR Performance" of 19 Oct 1972 -- AD45 247
(d) Naval Weather Service Command Summary of Synoptic Meteorological Observations
(e) Handbook of Chemistry and Physics, 37th Edition, Chemical Rubber Publishing Company (1955)
(f) NAVAIRDEVCEN Tech Memo NADC-20203:PMM, "Predictions of FLIR Performance Against Ships" of 12 Dec 1972

I. BACKGROUND

Reference (a) assigned NAVAIRDEVCEN the task of performing operational and system analyses and state-of-the-art technology surveys and projections as a first effort in the development of FLIR (forward looking infrared) equipments which would be affordable in large quantities and optimized for the missions of single-place attack aircraft.

One phase of this task is the calculation of the FLIR performance characteristics (resolution, sensitivity, field of view and frame rate) necessary to meet operational range requirements as a function of atmospheric conditions, aircraft altitude and target size, orientation, and effective thermal contrast. In these calculations, one of the crucial factors is the attenuation by the intervening atmosphere of the infrared radiation emitted by the target and received by the sensor.

Although the composition of the atmosphere is quite constant with regard to most of its constituents, it is quite variable over time and place with respect to water vapor, which is a principal absorber of

infrared radiation over the spectral range of interest (3 to 14 micrometers). Numerous studies of the transmission of infrared radiation as a function of the quantity of water vapor in the path have been reported in the literature and several methods of computation have been published which enable one to calculate atmospheric spectral transmission as a function of absolute humidity and path length. Unfortunately, there is a dearth of statistical data providing probabilities of occurrence of values of absolute humidity within given increments, and probabilities that given values of absolute humidity will not be exceeded in given times and places. Reference (b) provides a collection of 228 graphs representing the cumulative frequencies of occurrence of given concentrations of atmospheric water vapor for 19 marine locations for each of the 12 months of the year. These northern hemisphere sites were selected as being representative of the types of climate in which future naval operations might be expected to take place. This technical memorandum extends the earlier treatment by providing absolute humidity statistics on an annual basis in the form of absolute humidity histograms and cumulative frequency of occurrence curves for all of the sites both individually and collectively. The latter composite data will be taken as being representative of the marine absolute humidity environment of the world and will be used as an input to the FLIR mathematical model of reference (c). In the present study two additional sites, Atlantic City, New Jersey, and Key West, Florida, have been included to permit interpolating/extrapolating the results of NAVAIRDEVCEN FLIR evaluations in these areas to the other sites. The principal purpose of generating these statistics is to enable one to determine the absolute humidity for which a FLIR must be designed if it is not to be prevented, to any preselected degree of probability, from achieving its operational range requirements because of atmospheric water vapor.

## II. METHOD OF CALCULATION

Reference (d) provides monthly and annual statistical weather data for a large number of maritime areas throughout the northern hemisphere based largely on reports from ships. Typical reporting areas are rectangular in shape and cover latitude and longitude intervals of the order of two to four degrees. Each area is given a descriptive name which is usually that of an adjacent city or island. The 21 sites covered in this study are described in table I.

A representative page from Volume 2 of reference (d), which gives annual data for Atlantic City, is reproduced here as table II. Of particular interest on that page is "table 13" which gives the percent frequency that the relative humidity fell within each of eight

intervals of relative humidity while simultaneously the air temperature fell within each of 18 intervals of temperature over the recording period. If one takes the values of relative humidity and temperature at the center of each respective interval as being representative of the whole interval, one can then compute an "average" value of absolute humidity for each of the 144 two-dimensional relative humidity - temperature intervals. Reference (c) provides the basis for the formula

$$\text{Absolute Humidity} = 288.9 \frac{P}{T_A} H_r \ \text{gm/m}^3$$

in which P is the vapor pressure of water in mm of Hg, $T_A$ is the absolute temperature of the air in °K, and $H_r$ is the dimensionless relative humidity expressed in decimal form. Values of the vapor pressure of water over liquid water from reference (e) corresponding to values of $T_A$ at the center of each temperature interval and values of $H_r$ corresponding to the center of each relative humidity interval were used to compute the matrix of "average" values of absolute humidity given in table III. These values of absolute humidity, in conjunction with the percent frequencies of occurrence given in reference (d) for each site, were used to determine the values of frequency density for each 1.0-gm/m$^3$ absolute humidity interval and values of the cumulative frequency of occurrence given in tables IV and V for each of the 21 sites. In addition, these frequency data were summed and normalized to provide the composite distributions over the 21 sites also given in tables IV and V. A Hewlett-Packard HP-35 Pocket Calculator was used in performing the computations. The data of tables IV and V were subsequently hand plotted in figures 1 through 22, which are arranged in order of decreasing site latitude. Because reference (d) gives percent frequencies rounded off to the nearest 0.1%, the maximum values of the cumulative frequencies usually do not equal 100%. There may be some bias in the original data because of a preference of the reporting ships to avoid extremes of bad weather and because of a preference to work during the day rather than at night.

Figure 23 is a graph that enables one conveniently to convert the values of absolute humidity (gm/m$^3$) used in this technical memorandum to those (cm of precipitable water/nmi) used in reference (c). The composite data for the 21 selected sites in figure 22 were replotted in figure 24 with the absolute humidity expressed in centimeters of precipitable water vapor per nautical mile. This graph enables one to interpret the FLIR range predictions of reference (f) in probabilistic terms with respect to atmospheric water vapor concentration.

In reference (f), "high," "medium" and "low" values of absolute humidity of 5.5, 2.6 and 1.0 cm of precipitable water per nmi, respectively, were assumed in performing the calculations. Figure 24 shows that, averaged over the 21 selected sites, these values are not exceeded 99.5%, 44% and 10% of the time, respectively.

## III. ACKNOWLEDGEMENT

Sincere appreciation is extended to personnel of the Naval Weather Service Command, and in particular to LCDR D. D. Frame, for their assistance in selecting and providing the required relative humidity - temperature data.

Paul M. Moser

PAUL M. MOSER

TABLE I

SITE LOCATIONS AND DESCRIPTIONS

| SITE NO. | LATITUDE | LONGITUDE | SITE DESCRIPTION |
|---|---|---|---|
| 1 | 56 N-Coast | 151-157 W | Kodiak, Alaska (NE Pacific Ocean) |
| 2 | 45-47 N | 53-56 W | Argentia, Newfoundland (Atlantic Ocean SE of Newfoundland) |
| 3 | 42 N-Coast | 66 W-Coast | Boston, Mass. (Atlantic Ocean E of central Mass.) |
| 4 | 39.7 N | 129.4 E | Wonsan, North Korea (Sea of Japan) |
| 5 | 38-40 N | 72 W-Coast | Atlantic City, N.J. (Atlantic Ocean E of S N.J., Del. and N Md.) |
| 6 | 36-38 N | Coast-126 W | San Francisco, Calif. (Pacific Ocean S and W of central Calif.) |
| 7 | 37.9 N | 25.1 E | South Aegean Sea (E of Athens, Greece) |
| 8 | 36.0 N | 3.4 W | Malaga, Spain (W end of Mediterranean) |
| 9 | 36.0 N | 133.2 E | Matsue, Japan (S end of Sea of Japan) |
| 10 | 32.2 N | 33.3 E | Port Said, Egypt (SE Mediterranean) |
| 11 | 27.2 N | 50.2 E | NW Persian Gulf (between Saudi Arabia and Iran) |
| 12 | 25.0 N | 57.8 E | N Gulf of Oman (between Iran and Oman) |
| 13 | 23-25 N | 79-83 W | Key West, Fla. (Gulf of Mexico & Atlantic Ocean between Florida & Cuba) |
| 14 | 29.9 N | 67.8 E | Karachi, Pakistan (N Arabian Sea) |
| 15 | 20.4 N | 158.3 W | Hawaiian Leeward (Pacific Ocean S of Oahu) |
| 16 | 18-20 N | 74-76 W | Guantanamo, Cuba (Caribbean S of E Cuba) |
| 17 | 17-22 N | 110 E-Coast | S China Sea Area VII (E of North Vietnam) |
| 18 | 17.9 N | 85.2 E | Vishakhapatnam, India (Bay of Bengal E of S India) |
| 19 | 14.2 N | 73.0 E | Panjim, Goa (Arabian Sea W of S India) |
| 20 | 11-14 N | 111 E-Coast | S China Sea Area I (E of South Vietnam) |
| 21 | 7-11 N | 102 & 103 E-Coast | S. China Sea Area VI (Gulf of Siam adjoining Malaysia) |

ANNUAL

PERIOD: (PRIMARY) 1949-1968
(OVER-ALL) 1855-1968

AREA 007 ATLANTIC CITY
38-40N 72W-COAST

TABLE 13

PERCENT FREQUENCY OF RELATIVE HUMIDITY BY TEMP

| TEMP F | 0-29 | 30-39 | 40-49 | 50-59 | 60-69 | 70-79 | 80-89 | 90-100 | TOTAL OBS | PCT FREQ |
|---|---|---|---|---|---|---|---|---|---|---|
| 95/99 | .0 | * | .0 | .0 | .0 | .0 | .0 | .0 | 1 | * |
| 90/94 | .0 | * | * | .0 | * | * | * | .0 | 21 | .1 |
| 85/89 | * | * | * | * | .1 | .2 | .1 | * | 146 | .4 |
| 80/84 | * | * | * | .1 | .4 | .7 | .9 | .4 | 877 | 2.5 |
| 75/79 | * | * | .1 | .3 | .6 | 1.9 | 3.0 | 3.3 | 3197 | 9.2 |
| 70/74 | * | * | .1 | .6 | 1.6 | 2.3 | 3.5 | 5.4 | 4725 | 13.5 |
| 65/69 | * | * | .1 | .5 | 1.0 | 1.8 | 3.0 | 3.8 | 3575 | 10.2 |
| 60/64 | * | * | .2 | .6 | 1.5 | 2.3 | 3.3 | 3.1 | 3817 | 10.9 |
| 55/59 | * | * | .2 | .7 | 1.4 | 2.4 | 3.4 | 2.5 | 3714 | 10.6 |
| 50/54 | * | .1 | .3 | .8 | 2.0 | 2.2 | 3.9 | 2.7 | 4163 | 11.9 |
| 45/49 | * | .1 | .3 | .9 | 1.7 | 3.1 | 2.9 | 2.7 | 4076 | 11.7 |
| 40/44 | * | .1 | .2 | .7 | 2.5 | 2.2 | 2.1 | 2.0 | 3432 | 9.8 |
| 35/39 | * | * | .1 | .7 | 1.2 | 1.2 | 1.1 | 1.0 | 1898 | 5.4 |
| 30/34 | * | * | .1 | .2 | .4 | .5 | .6 | .6 | 858 | 2.5 |
| 25/29 | * | * | * | .1 | .1 | .2 | .1 | .2 | 301 | .9 |
| 20/24 | * | * | * | * | * | * | * | .1 | 82 | .2 |
| 15/19 | .0 | .0 | .0 | .0 | * | * | * | * | 6 | * |
| 10/14 | .0 | .0 | * | .0 | .0 | .0 | .0 | * | 2 | * |
| TOTAL | 79 | 149 | 670 | 2166 | 5030 | 7281 | 9750 | 9766 | 34891 | 100.0 |
| PCT | .2 | .4 | 1.9 | 6.2 | 14.4 | 20.9 | 27.9 | 28.0 | | |

TABLE 14

PERCENT FREQUENCY OF WIND DIRECTION BY TEMP

| N | NE | E | SE | S | SW | W | NW | VAR | CALM |
|---|---|---|---|---|---|---|---|---|---|
| .0 | * | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| * | * | * | * | * | * | .0 | * | .0 | .0 |
| * | * | * | .1 | .1 | .1 | .1 | * | .0 | * |
| .1 | .2 | .1 | .2 | .8 | .7 | .2 | .1 | * | .1 |
| .6 | .7 | .7 | .9 | 2.6 | 2.2 | .8 | .5 | * | .3 |
| 1.2 | 1.6 | 1.3 | 1.3 | 3.2 | 2.4 | 1.2 | .8 | * | .5 |
| 1.3 | 1.3 | .9 | .9 | 2.0 | 1.6 | .9 | .8 | * | .3 |
| 1.3 | 1.4 | 1.0 | .9 | 2.1 | 1.9 | 1.1 | 1.0 | * | .3 |
| 1.3 | 1.1 | .8 | .9 | 2.0 | 1.9 | 1.3 | 1.1 | * | .2 |
| 1.4 | 1.3 | .9 | 1.0 | 1.9 | 1.9 | 1.6 | 1.6 | .0 | .3 |
| 1.5 | 1.1 | .9 | .6 | 1.4 | 1.6 | 2.1 | 2.2 | * | .3 |
| 1.6 | .9 | .6 | .4 | .6 | 1.0 | 2.0 | 2.5 | .0 | .2 |
| 1.0 | .5 | .2 | .1 | .1 | .3 | 1.2 | 1.9 | * | .1 |
| .4 | .1 | .1 | * | * | .1 | .6 | 1.1 | .0 | * |
| .1 | * | * | * | * | * | .2 | .4 | .0 | .0 |
| * | * | .0 | .0 | .0 | * | .1 | .1 | .0 | .0 |
| .0 | * | .0 | .0 | .0 | .0 | * | * | .0 | .0 |
| * | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 4199 | 3588 | 2646 | 2520 | 5920 | 5499 | 4633 | 4982 | 24 | [illegible] |
| 12.0 | 10.3 | 7.6 | 7.2 | 17.0 | 15.8 | 13.3 | 14.3 | .1 | 2.5 |

TABLE 15

MEANS, EXTREMES AND PERCENTILES OF TEMP (DEG F) BY HOUR

| HOUR (GMT) | MAX | 99% | 95% | 50% | 5% | 1% | MIN | MEAN | TOTAL OBS |
|---|---|---|---|---|---|---|---|---|---|
| 00&03 | 93 | 83 | 79 | 59 | 36 | 28 | 14 | 58.0 | 11086 |
| 06&09 | 88 | 80 | 77 | 57 | 34 | 25 | 12 | 56.1 | 18575 |
| 12&15 | 92 | 81 | 77 | 57 | 35 | 26 | 12 | 56.9 | 10622 |
| 18&21 | 93- | 85 | 82 | 60 | 33 | 26 | 14 | 59.0 | 13774 |
| TOT | 93 | 82 | 77 | 57 | 34 | 25 | 12 | 57.4 | 54057 |

TABLE 16

PERCENT FREQUENCY OF RELATIVE HUMIDITY BY HOUR

| HOUR (GMT) | 0-29 | 30-59 | 60-69 | 70-79 | 80-89 | 90-100 | MEAN | TOTAL OBS |
|---|---|---|---|---|---|---|---|---|
| 00&03 | * | 1.8 | 3.2 | 4.8 | 6.9 | 6.7 | 80 | [illegible] |
| 06&09 | * | 2.0 | 3.8 | 5.9 | 8.9 | 10.1 | 81 | [illegible] |
| 12&15 | .1 | 1.6 | 3.1 | 4.5 | 6.3 | 6.8 | 81 | [illegible] |
| 18&21 | .1 | 3.1 | 4.3 | 5.7 | 5.8 | 4.4 | 76 | [illegible] |
| TOT | 80 | 2998 | 5049 | 7318 | 9790 | 9821 | 80 | [illegible] |

**TABLE II**

**REPRESENTATIVE PAGE OF ANNUAL DATA FOR ATLANTIC CITY, NEW JERSEY, REPRODUCED FROM NAVAL WEATHER SERVICE COMMAND SUMMARY OF SYNOPTIC METEOROLOGICAL OBSERVATIONS**

TABLE III
"AVERAGE" VALUES OF ABSOLUTE HUMIDITY ($gm/m^3$) CORRESPONDING
TO VARIOUS RELATIVE HUMIDITY - TEMPERATURE INTERVALS

| Temperature Interval (°F) | Average Temperature of Interval (°F) | Average Temperature of Interval (°C) | Relative Humidity Interval (%) 0-29 | 30-39 | 40-49 | 50-59 | 60-69 | 70-79 | 80-89 | 90-100 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average Relative Humidity of Interval (%) 14.5 | 34.5 | 44.5 | 54.5 | 64.5 | 74.5 | 84.5 | 95 |
| 100/104 | 102 | 38.9 | 7.00+ | 16.66 | 21.49 | 26.31 | 31.14 | 35.97 | 40.80 | 45.87 |
| 95/99 | 97 | 36.1 | 6.07 | 14.44 | 18.62 | 22.81 | 26.99 | 31.18 | 35.36 | 39.76 |
| 90/94 | 92 | 33.3 | 5.25 | 12.48 | 16.10 | 19.71 | 23.33 | 26.95 | 30.56 | 34.36 |
| 85/89 | 87 | 30.6 | 4.54 | 10.80 | 13.93 | 17.06 | 20.20 | 23.33 | 26.46 | 29.75 |
| 80/84 | 82 | 27.8 | 3.90 | 9.28 | 11.97 | 14.66 | 17.34 | 20.03 | 22.72 | 25.55 |
| 75/79 | 77 | 25.0 | 3.34 | 7.94 | 10.24 | 12.55 | 14.85 | 17.15 | 19.45 | 21.87 |
| 70/74 | 72 | 22.2 | 2.85 | 6.77 | 8.74 | 10.70 | 12.66 | 14.62 | 16.59 | 18.65 |
| 65/69 | 67 | 19.4 | 2.42 | 5.76 | 7.42 | 9.09 | 10.76 | 12.43 | 14.10 | 15.85 |
| 60/64 | 62 | 16.7 | 2.06 | 4.90 | 6.32 | 7.74 | 9.17 | 10.59 | 12.01 | 13.50 |
| 55/59 | 57 | 13.9 | 1.74 | 4.13 | 5.33 | 6.53 | 7.73 | 8.93 | 10.12 | 11.38 |
| 50/54 | 52 | 11.1 | 1.46 | 3.47 | 4.48 | 5.49 | 6.50 | 7.50 | 8.51 | 9.57 |
| 45/49 | 47 | 8.3 | 1.22 | 2.91 | 3.75 | 4.59 | 5.44 | 6.28 | 7.12 | 8.01 |
| 40/44 | 42 | 5.6 | 1.03 | 2.44 | 3.15 | 3.85 | 4.56 | 5.27 | 5.97 | 6.72 |
| 35/39 | 37 | 2.8 | 0.85 | 2.03 | 2.61 | 3.20 | 3.79 | 4.37 | 4.96 | 5.58 |
| 30/34 | 32 | 0 | 0.70 | 1.67 | 2.15 | 2.64 | 3.12 | 3.61 | 4.09 | 4.60 |
| 25/29 | 27 | -2.8 | 0.58 | 1.38 | 1.78 | 2.18 | 2.57 | 2.97 | 3.37 | 3.79 |
| 20/24 | 22 | -5.6 | 0.47 | 1.13 | 1.45 | 1.78 | 2.10 | 2.43 | 2.76 | 3.10 |
| 15/19 | 17 | -8.3 | 0.39 | 0.93 | 1.19 | 1.46 | 1.73 | 2.00- | 2.27 | 2.55 |
| 10/14 | 12 | -11.1 | 0.32 | 0.75 | 0.97 | 1.18 | 1.40 | 1.62 | 1.83 | 2.06 |
| 5/9 | 7 | -13.9 | 0.25 | 0.60 | 0.78 | 0.95 | 1.13 | 1.30 | 1.48 | 1.66 |
| 0/4 | 2 | -16.7 | 0.20 | 0.49 | 0.63 | 0.77 | 0.91 | 1.05 | 1.19 | 1.34 |

TABLE IV

ANNUAL FREQUENCY DENSITIES OF OCCURRENCE WITHIN GIVEN ABSOLUTE HUMIDITY INTERVALS FOR SELECTED MARINE SITES (PERCENT)

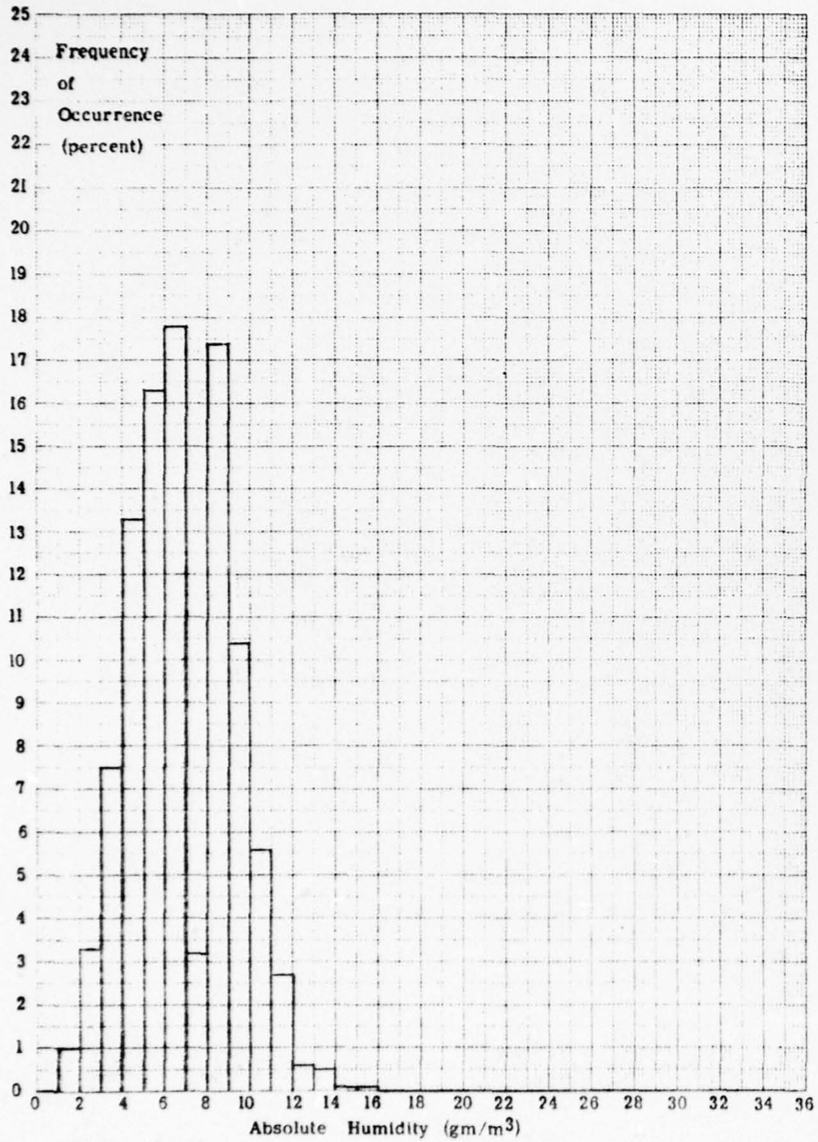
| Absolute Humidity Interval (gm/m³) | Site Number 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0-1 | 0.0 | 0.0 | 0.2 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1-2 | 1.0 | 0.2 | 0.7 | 1.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 2-3 | 3.3 | 3.3 | 4.9 | 4.3 | 1.0 | 0.0 | 0.0 | 0.0 | 2.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 |
| 3-4 | 7.5 | 9.0 | 8.8 | 11.5 | 4.5 | 0.1 | 0.6 | 0.0 | 7.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.3 |
| 4-5 | 13.3 | 18.5 | 11.4 | 12.3 | 7.2 | 0.2 | 1.9 | 0.2 | 7.4 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.5 |
| 5-6 | 16.3 | 16.4 | 12.4 | 9.1 | 8.0 | 1.1 | 3.1 | 1.6 | 7.4 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.6 |
| 6-7 | 17.8 | 10.3 | 8.3 | 7.3 | 8.0 | 4.5 | 5.4 | 3.0 | 6.1 | 0.9 | 0.3 | 0.3 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.4 |
| 7-8 | 3.2 | 4.9 | 6.5 | 6.6 | 7.2 | 8.9 | 9.4 | 5.8 | 6.8 | 3.8 | 1.4 | 0.7 | 0.4 | 1.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.2 |
| 8-9 | 17.4 | 11.7 | 12.2 | 5.5 | 9.1 | 20.1 | 9.2 | 11.2 | 6.5 | 4.1 | 0.2 | 0.6 | 0.3 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.2 |
| 9-10 | 10.4 | 6.9 | 8.0 | 2.2 | 4.7 | 9.7 | 6.2 | 3.4 | 4.6 | 5.9 | 3.0 | 1.0 | 1.0 | 1.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.3 |
| 10-11 | 5.6 | 4.6 | 5.9 | 4.9 | 7.4 | 24.1 | 15.9 | 18.6 | 8.2 | 16.9 | 5.4 | 3.8 | 2.4 | 3.9 | 0.8 | 0.2 | 0.0 | 0.7 | 0.0 | 0.0 | 0.0 | 6.2 |
| 11-12 | 2.7 | 6.8 | 5.1 | 1.5 | 2.5 | 12.8 | 2.1 | 2.0 | 2.0 | 0.8 | 0.5 | 0.4 | 0.0 | 0.3 | 0.1 | 0.0 | 0.3 | 0.1 | 0.2 | 0.0 | 0.0 | 1.9 |
| 12-13 | 0.6 | 2.1 | 4.1 | 5.8 | 7.0 | 11.1 | 14.5 | 16.0 | 7.3 | 14.5 | 8.4 | 7.5 | 5.6 | 6.6 | 4.5 | 1.1 | 0.6 | 3.4 | 0.4 | 0.0 | 0.1 | 5.8 |
| 13-14 | 0.5 | 3.5 | 3.7 | 2.5 | 3.1 | 4.8 | 1.4 | 2.9 | 2.9 | 2.3 | 1.7 | 0.3 | 0.1 | 0.1 | 0.1 | 0.1 | 0.3 | 0.0 | 0.1 | 0.0 | 0.3 | 1.5 |
| 14-15 | 0.1 | 0.3 | 2.5 | 6.6 | 6.0 | 1.3 | 13.3 | 12.8 | 5.7 | 13.2 | 11.2 | 10.2 | 8.8 | 8.2 | 14.9 | 4.8 | 3.1 | 7.5 | 2.5 | 0.8 | 1.0 | 6.4 |
| 15-16 | 0.1 | 0.6 | 2.7 | 4.2 | 3.8 | 0.6 | 0.8 | 3.3 | 3.6 | 0.9 | 3.0 | 0.3 | 0.8 | 0.7 | 0.3 | 0.1 | 0.7 | 0.1 | 0.0 | 0.0 | 0.0 | 1.3 |
| 16-17 | 0.0 | 0.0 | 0.4 | 3.3 | 3.5 | 0.1 | 2.8 | 4.4 | 3.3 | 2.9 | 4.4 | 3.9 | 3.7 | 3.6 | 5.8 | 1.6 | 2.0 | 0.7 | 0.0 | 0.4 | 0.0 | 2.2 |
| 17-18 | 0.0 | 0.0 | 0.3 | 1.9 | 2.3 | 0.0 | 8.1 | 5.2 | 2.4 | 14.0 | 7.8 | 9.7 | 15.9 | 8.4 | 37.7 | 20.6 | 6.5 | 11.9 | 11.3 | 6.1 | 6.1 | 8.4 |
| 18-19 | 0.0 | 0.0 | 0.7 | 2.9 | 5.4 | 0.0 | 0.8 | 3.5 | 3.8 | 1.6 | 3.3 | 1.7 | 2.6 | 2.1 | 3.0 | 0.7 | 2.3 | 0.4 | 0.1 | 0.7 | 0.3 | 1.7 |
| 19-20 | 0.0 | 0.0 | 0.1 | 2.8 | 3.0 | 0.0 | 1.0 | 2.8 | 2.8 | 5.3 | 5.1 | 4.9 | 10.0 | 6.8 | 13.4 | 9.4 | 8.3 | 5.0 | 4.3 | 9.1 | 3.9 | 4.7 |
| 20-21 | 0.0 | 0.0 | 0.0 | 0.5 | 0.8 | 0.0 | 2.4 | 1.2 | 1.2 | 6.5 | 6.7 | 8.0 | 18.5 | 9.7 | 9.7 | 27.4 | 13.6 | 9.3 | 26.7 | 20.9 | 31.1 | 9.2 |
| 21-22 | 0.0 | 0.0 | 0.0 | 1.1 | 3.3 | 0.0 | 0.3 | 1.3 | 3.5 | 2.1 | 1.8 | 2.0 | 4.3 | 3.9 | 4.8 | 3.1 | 7.3 | 2.7 | 4.4 | 6.9 | 3.7 | 2.7 |
| 22-23 | 0.0 | 0.0 | 0.0 | 1.1 | 0.9 | 0.0 | 0.1 | 0.3 | 3.2 | 1.9 | 4.3 | 7.2 | 13.3 | 24.3 | 2.5 | 17.3 | 22.0 | 24.3 | 27.6 | 32.3 | 30.9 | 10.2 |
| 23-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.4 | 0.1 | 0.2 | 1.2 | 9.2 | 10.4 | 7.2 | 2.9 | 0.6 | 7.4 | 15.1 | 8.4 | 10.2 | 9.0 | 14.7 | 4.6 |
| 24-25 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-26 | 0.0 | 0.0 | 0.0 | 0.2 | 0.4 | 0.0 | 0.2 | 0.0 | 1.4 | 0.3 | 2.4 | 3.3 | 2.6 | 7.9 | 1.3 | 3.5 | 6.1 | 8.7 | 7.4 | 7.5 | 3.9 | 2.7 |
| 26-27 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.4 | 0.4 | 11.1 | 16.1 | 1.7 | 5.7 | 0.5 | 2.2 | 9.2 | 14.4 | 3.6 | 5.0 | 3.8 | 3.5 |
| 27-28 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-29 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 29-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.9 | 3.1 | 0.4 | 0.8 | 0.1 | 0.4 | 1.8 | 2.0 | 0.7 | 1.0 | 0.5 | 0.7 |
| 30-31 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.5 | 3.0 | 0.1 | 0.1 | 0.0 | 0.1 | 0.4 | 0.2 | 0.2 | 0.3 | 0.0 | 0.4 |
| 31-32 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 32-33 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 33-34 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 34-35 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.1 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.1 |
| 35-36 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 36-37 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

TABLE V
ANNUAL CUMULATIVE FREQUENCIES OF OCCURRENCE OF GIVEN VALUES
OF ABSOLUTE HUMIDITY FOR SELECTED MARINE SITES (PERCENT)

| Absolute Humidity ($gm/m^3$) | Site Number 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.5 | 0.0 | 0.0 | 0.2 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1.5 | 1.0 | 0.2 | 0.9 | 1.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2.5 | 4.3 | 3.5 | 5.8 | 5.8 | 1.0 | 0.0 | 0.0 | 0.0 | 2.3 | 0.0 | 0.0 |
| 3.5 | 11.8 | 12.5 | 14.6 | 17.3 | 5.5 | 0.1 | 0.6 | 0.0 | 9.3 | 0.0 | 0.0 |
| 4.5 | 25.1 | 31.0 | 26.0 | 29.6 | 12.7 | 0.3 | 2.5 | 0.2 | 16.7 | 0.1 | 0.0 |
| 5.5 | 41.4 | 47.4 | 38.4 | 38.7 | 20.7 | 1.4 | 5.6 | 1.8 | 24.1 | 0.2 | 0.0 |
| 6.5 | 59.2 | 57.7 | 46.7 | 46.0 | 28.7 | 5.9 | 11.0 | 4.8 | 30.2 | 1.1 | 0.3 |
| 7.5 | 62.4 | 62.6 | 53.2 | 52.6 | 35.9 | 14.8 | 20.4 | 10.6 | 37.0 | 4.9 | 1.7 |
| 8.5 | 79.8 | 74.3 | 65.4 | 58.1 | 45.0 | 34.9 | 29.6 | 21.8 | 43.5 | 9.0 | 1.9 |
| 9.5 | 90.2 | 81.2 | 73.4 | 60.3 | 49.7 | 44.6 | 35.8 | 25.2 | 48.1 | 14.9 | 4.9 |
| 10.5 | 95.8 | 85.8 | 79.3 | 65.2 | 57.1 | 68.7 | 51.7 | 43.8 | 56.3 | 31.8 | 10.3 |
| 11.5 | 98.5 | 92.6 | 84.4 | 66.7 | 59.6 | 81.5 | 53.8 | 45.8 | 58.3 | 32.6 | 10.8 |
| 12.5 | 99.1 | 94.7 | 88.5 | 72.5 | 66.6 | 92.6 | 68.3 | 61.8 | 65.6 | 47.1 | 19.2 |
| 13.5 | 99.6 | 98.2 | 92.2 | 75.0 | 69.7 | 97.4 | 69.7 | 64.7 | 68.5 | 49.4 | 20.9 |
| 14.5 | 99.7 | 98.5 | 94.7 | 81.6 | 75.7 | 98.7 | 83.0 | 77.5 | 74.2 | 62.6 | 32.1 |
| 15.5 | 99.8 | 99.1 | 97.4 | 85.8 | 79.5 | 99.3 | 83.8 | 80.8 | 77.8 | 63.5 | 35.1 |
| 16.5 | 99.8 | 99.1 | 97.8 | 89.1 | 83.0 | 99.4 | 86.6 | 85.2 | 81.1 | 66.4 | 39.5 |
| 17.5 | 99.8 | 99.1 | 98.1 | 91.0 | 85.3 | 99.4 | 94.7 | 90.4 | 83.5 | 80.4 | 47.3 |
| 18.5 | 99.8 | 99.1 | 98.8 | 93.9 | 90.7 | 99.4 | 95.5 | 93.9 | 87.3 | 82.0 | 50.6 |
| 19.5 | 99.8 | 99.1 | 98.9 | 96.7 | 93.7 | 99.4 | 96.5 | 96.7 | 90.1 | 87.3 | 55.7 |
| 20.5 | 99.8 | 99.1 | 98.9 | 97.2 | 94.5 | 99.4 | 98.9 | 97.9 | 91.3 | 93.8 | 62.4 |
| 21.5 | 99.8 | 99.1 | 98.9 | 98.3 | 97.8 | 99.4 | 99.2 | 99.2 | 94.8 | 95.9 | 64.2 |
| 22.5 | 99.8 | 99.1 | 98.9 | 99.4 | 98.7 | 99.4 | 99.3 | 99.5 | 98.0 | 97.8 | 68.5 |
| 23.5 | 99.8 | 99.1 | 98.9 | 99.4 | 98.9 | 99.4 | 99.7 | 99.6 | 98.2 | 99.0 | 77.7 |
| 24.5 | 99.8 | 99.1 | 98.9 | 99.4 | 98.9 | 99.4 | 99.7 | 99.6 | 98.2 | 99.0 | 77.7 |
| 25.5 | 99.8 | 99.1 | 98.9 | 99.6 | 99.3 | 99.4 | 99.9 | 99.6 | 99.6 | 99.3 | 80.1 |
| 26.5 | 99.8 | 99.1 | 98.9 | 99.7 | 99.4 | 99.4 | 99.9 | 99.6 | 100.0 | 99.7 | 91.2 |
| 27.5 | 99.8 | 99.1 | 98.9 | 99.7 | 99.4 | 99.4 | 99.9 | 99.6 | 100.0 | 99.7 | 91.2 |
| 28.5 | 99.8 | 99.1 | 98.9 | 99.7 | 99.4 | 99.4 | 99.9 | 99.6 | 100.0 | 99.7 | 91.2 |
| 29.5 | 99.8 | 99.1 | 98.9 | 99.7 | 99.4 | 99.4 | 99.9 | 99.6 | 100.0 | 99.7 | 94.1 |
| 30.5 | 99.8 | 99.1 | 98.9 | 99.7 | 99.4 | 99.4 | 99.9 | 99.6 | 100.0 | 99.7 | 97.6 |
| 31.5 | 99.8 | 99.1 | 98.9 | 99.7 | 99.4 | 99.4 | 99.9 | 99.6 | 100.0 | 99.7 | 98.4 |
| 32.5 | 99.8 | 99.1 | 98.9 | 99.7 | 99.4 | 99.4 | 99.9 | 99.6 | 100.0 | 99.7 | 98.4 |
| 33.5 | 99.8 | 99.1 | 98.9 | 99.7 | 99.4 | 99.4 | 99.9 | 99.6 | 100.0 | 99.7 | 98.4 |
| 34.5 | 99.8 | 99.1 | 98.9 | 99.7 | 99.4 | 99.4 | 99.9 | 99.6 | 100.0 | 99.7 | 99.5 |
| 35.5 | 99.8 | 99.1 | 98.9 | 99.7 | 99.4 | 99.4 | 99.9 | 99.6 | 100.0 | 99.7 | 100.0 |
| 36.5 | 99.8 | 99.1 | 98.9 | 99.7 | 99.4 | 99.4 | 99.9 | 99.6 | 100.0 | 99.7 | 100.0 |

| Absolute Humidity ($gm/m^3$) | Site Number 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 |
| 2.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.1 |
| 3.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.4 |
| 4.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 6.9 |
| 5.5 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 10.5 |
| 6.5 | 0.4 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 14.0 |
| 7.5 | 1.1 | 0.4 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 17.1 |
| 8.5 | 1.7 | 0.7 | 2.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 22.4 |
| 9.5 | 2.7 | 1.7 | 3.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 25.6 |
| 10.5 | 6.5 | 4.1 | 7.7 | 0.8 | 0.2 | 0.0 | 0.7 | 0.0 | 0.0 | 0.0 | 31.8 |
| 11.5 | 6.9 | 4.1 | 8.0 | 0.9 | 0.2 | 0.3 | 0.8 | 0.2 | 0.0 | 0.0 | 33.7 |
| 12.5 | 14.4 | 9.7 | 14.6 | 5.4 | 1.3 | 0.9 | 4.2 | 0.6 | 0.0 | 0.1 | 38.5 |
| 13.5 | 14.7 | 9.8 | 14.7 | 5.5 | 1.4 | 1.2 | 4.2 | 0.7 | 0.0 | 0.4 | 41.0 |
| 14.5 | 24.9 | 18.6 | 22.9 | 20.4 | 6.2 | 4.3 | 11.7 | 3.2 | 0.8 | 1.4 | 47.4 |
| 15.5 | 25.2 | 19.4 | 23.6 | 20.7 | 6.3 | 5.0 | 11.8 | 3.2 | 0.8 | 1.4 | 48.7 |
| 16.5 | 29.1 | 23.1 | 27.2 | 26.5 | 7.9 | 7.0 | 12.5 | 3.2 | 1.2 | 1.4 | 50.9 |
| 17.5 | 38.8 | 39.0 | 35.6 | 64.2 | 28.5 | 13.5 | 24.4 | 14.5 | 7.3 | 7.5 | 59.3 |
| 18.5 | 40.5 | 41.6 | 37.7 | 67.2 | 29.2 | 15.8 | 24.8 | 14.6 | 8.0 | 7.8 | 61.1 |
| 19.5 | 45.4 | 51.6 | 44.5 | 80.6 | 38.6 | 24.1 | 29.8 | 18.9 | 17.1 | 11.7 | 65.7 |
| 20.5 | 53.4 | 70.1 | 54.2 | 90.3 | 66.0 | 37.7 | 39.1 | 45.6 | 38.0 | 42.8 | 75.0 |
| 21.5 | 55.4 | 74.4 | 58.1 | 95.1 | 69.1 | 45.0 | 41.8 | 50.0 | 44.9 | 46.5 | 77.7 |
| 22.5 | 62.6 | 87.7 | 82.4 | 97.6 | 86.4 | 67.0 | 66.1 | 77.6 | 77.2 | 77.4 | 87.9 |
| 23.5 | 73.0 | 94.9 | 85.3 | 98.2 | 93.8 | 82.0 | 74.5 | 87.0 | 86.2 | 92.1 | 92.5 |
| 24.5 | 73.0 | 94.9 | 85.3 | 98.2 | 93.8 | 82.0 | 74.5 | 87.0 | 86.2 | 92.1 | 92.5 |
| 25.5 | 76.3 | 97.5 | 93.2 | 99.5 | 97.3 | 88.2 | 83.2 | 94.4 | 93.7 | 96.0 | 95.2 |
| 26.5 | 92.4 | 99.2 | 98.9 | 100.0 | 99.5 | 97.4 | 97.6 | 98.0 | 98.7 | 99.8 | 98.8 |
| 27.5 | 92.4 | 99.2 | 98.9 | 100.0 | 99.5 | 97.4 | 97.6 | 98.0 | 98.7 | 99.8 | 98.8 |
| 28.5 | 92.4 | 99.2 | 98.9 | 100.0 | 99.5 | 97.4 | 97.6 | 98.0 | 98.7 | 99.8 | 98.8 |
| 29.5 | 95.5 | 99.6 | 99.7 | 100.1 | 99.9 | 99.2 | 99.6 | 98.7 | 99.7 | 100.3 | 99.5 |
| 30.5 | 98.5 | 99.7 | 99.8 | 100.1 | 100.0 | 99.6 | 99.8 | 98.9 | 100.0 | 100.3 | 99.8 |
| 31.5 | 98.9 | 99.7 | 99.8 | 100.1 | 100.0 | 99.6 | 99.8 | 98.9 | 100.0 | 100.3 | 99.9 |
| 32.5 | 98.9 | 99.7 | 99.8 | 100.1 | 100.0 | 99.6 | 99.8 | 98.9 | 100.0 | 100.3 | 99.9 |
| 33.5 | 98.9 | 99.7 | 99.8 | 100.1 | 100.0 | 99.6 | 99.8 | 98.9 | 100.0 | 100.3 | 99.9 |
| 34.5 | 99.5 | 99.7 | 99.8 | 100.1 | 100.0 | 99.6 | 99.9 | 98.9 | 100.1 | 100.3 | 100.0 |
| 35.5 | 99.6 | 99.7 | 99.8 | 100.1 | 100.0 | 99.6 | 99.9 | 98.9 | 100.1 | 100.3 | 100.0 |
| 36.5 | 99.6 | 99.7 | 99.8 | 100.1 | 100.0 | 99.6 | 99.9 | 98.9 | 100.1 | 100.3 | 100.0 |

FIGURE 1.  ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - KODIAK, ALASKA



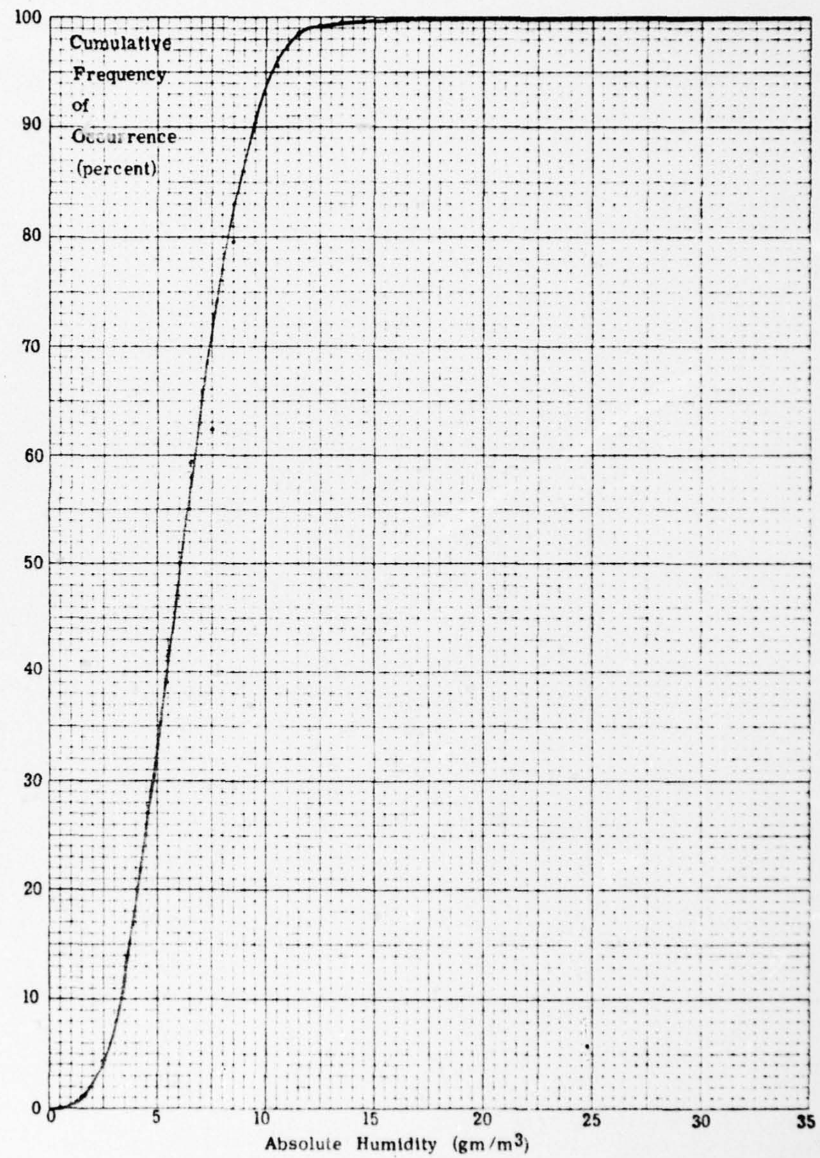
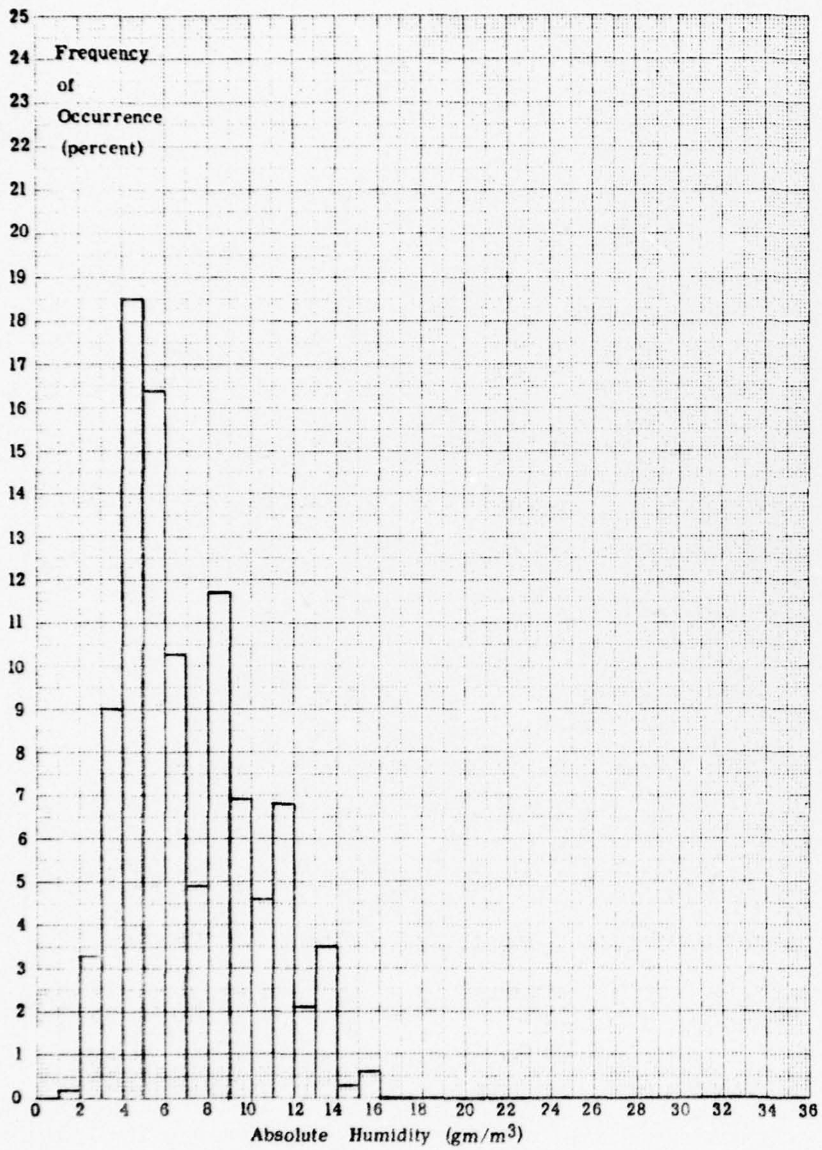



FIGURE 2. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - ARGENTIA, NEWFOUNDLAND



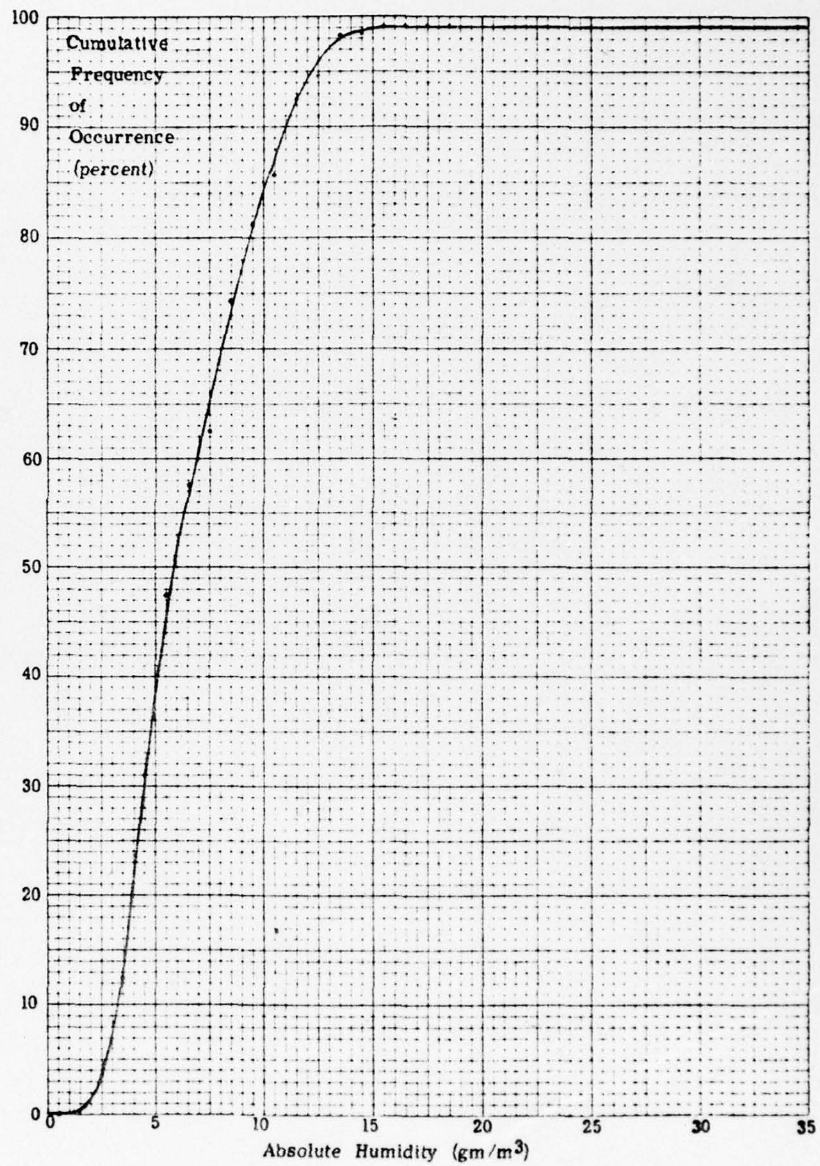



FIGURE 3. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - BOSTON, MASSACHUSETTS

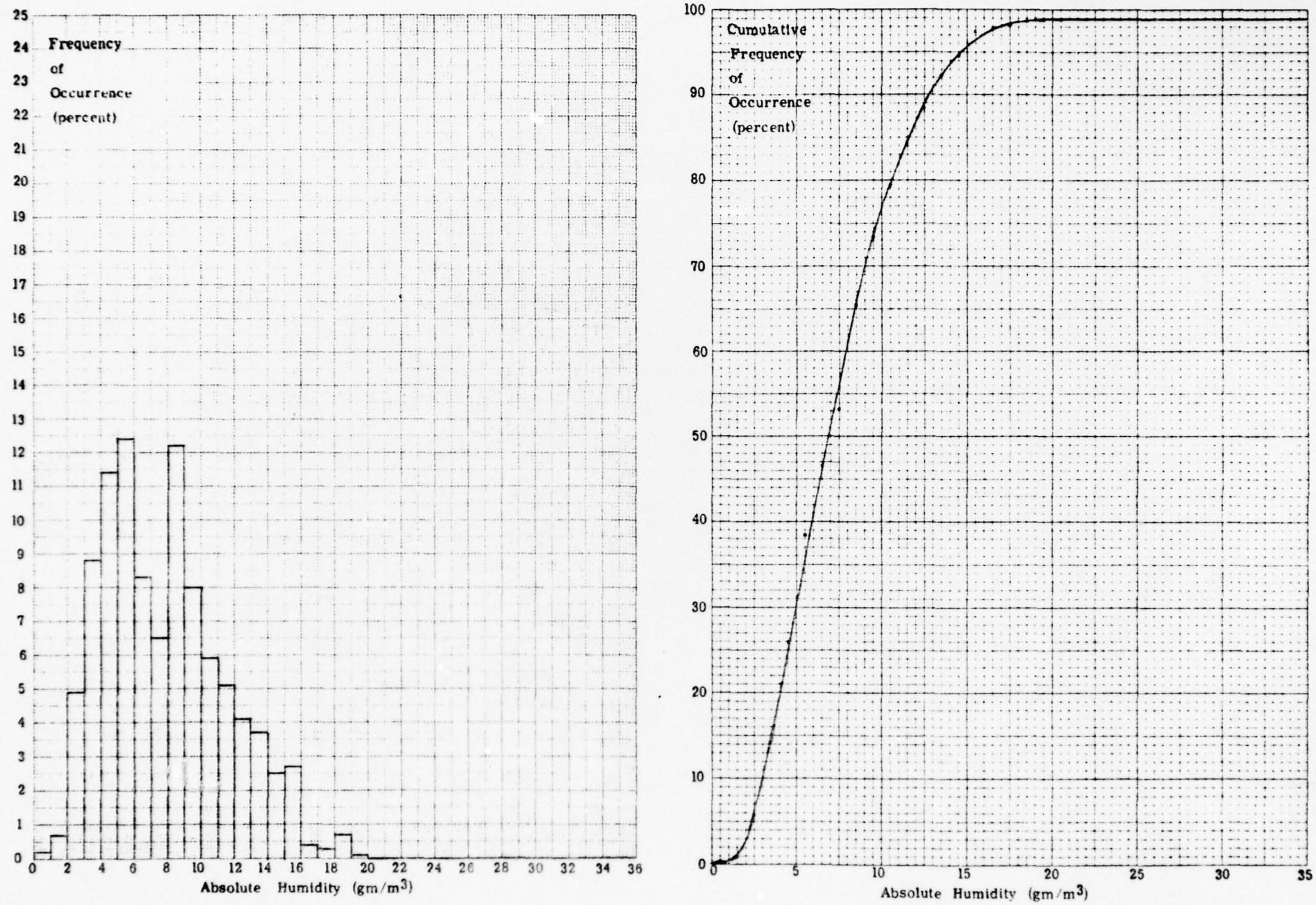
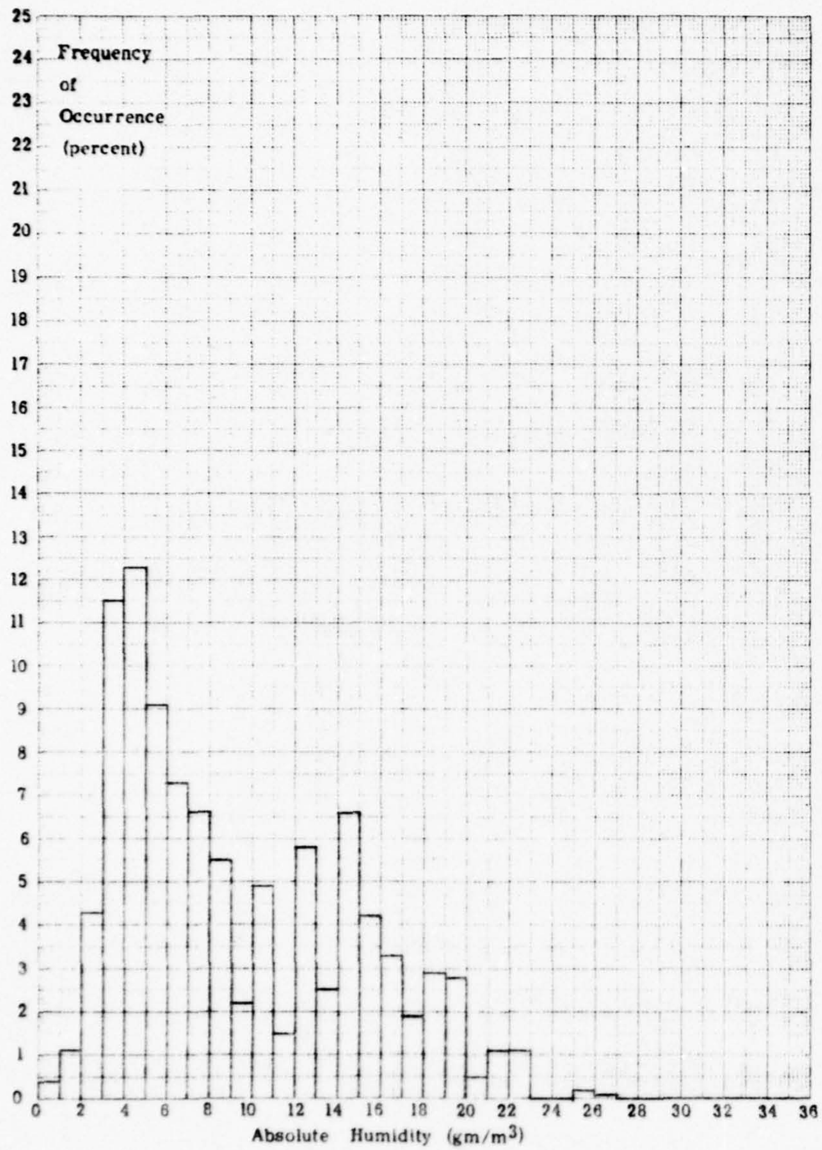


FIGURE 4. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - WONSAN, NORTH KOREA



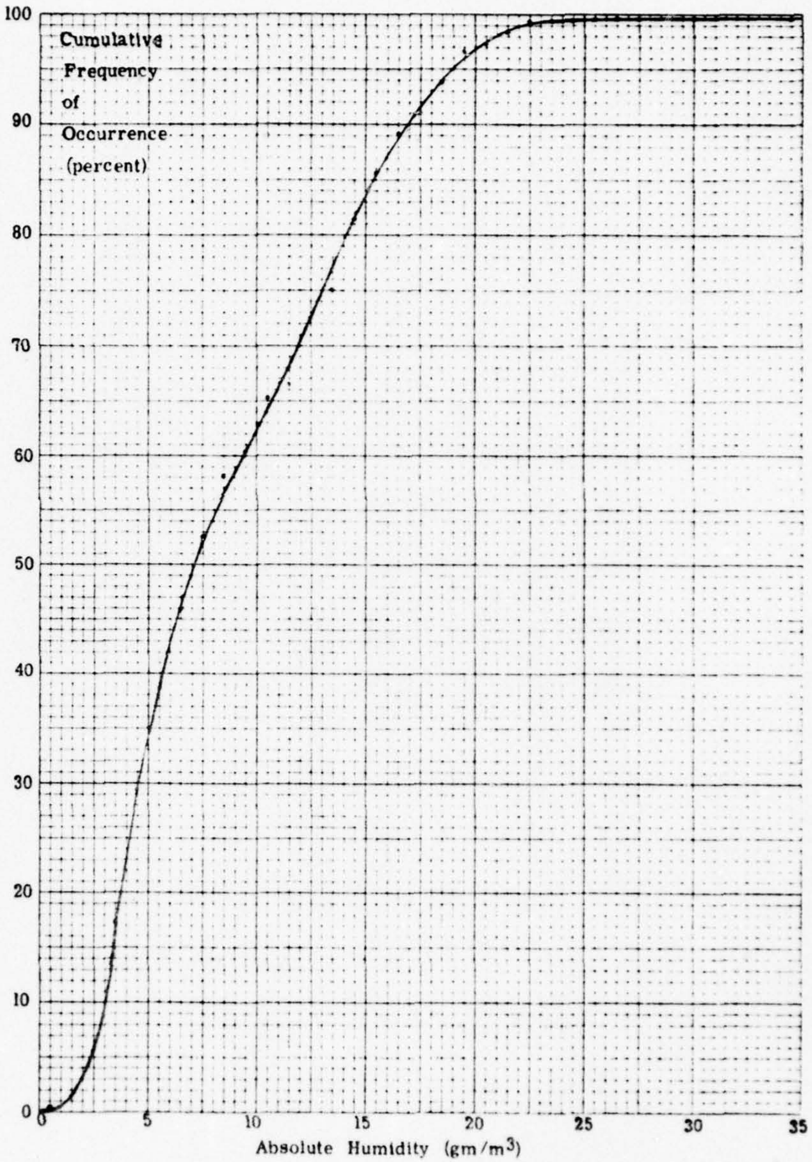



FIGURE 5. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - ATLANTIC CITY, NEW JERSEY

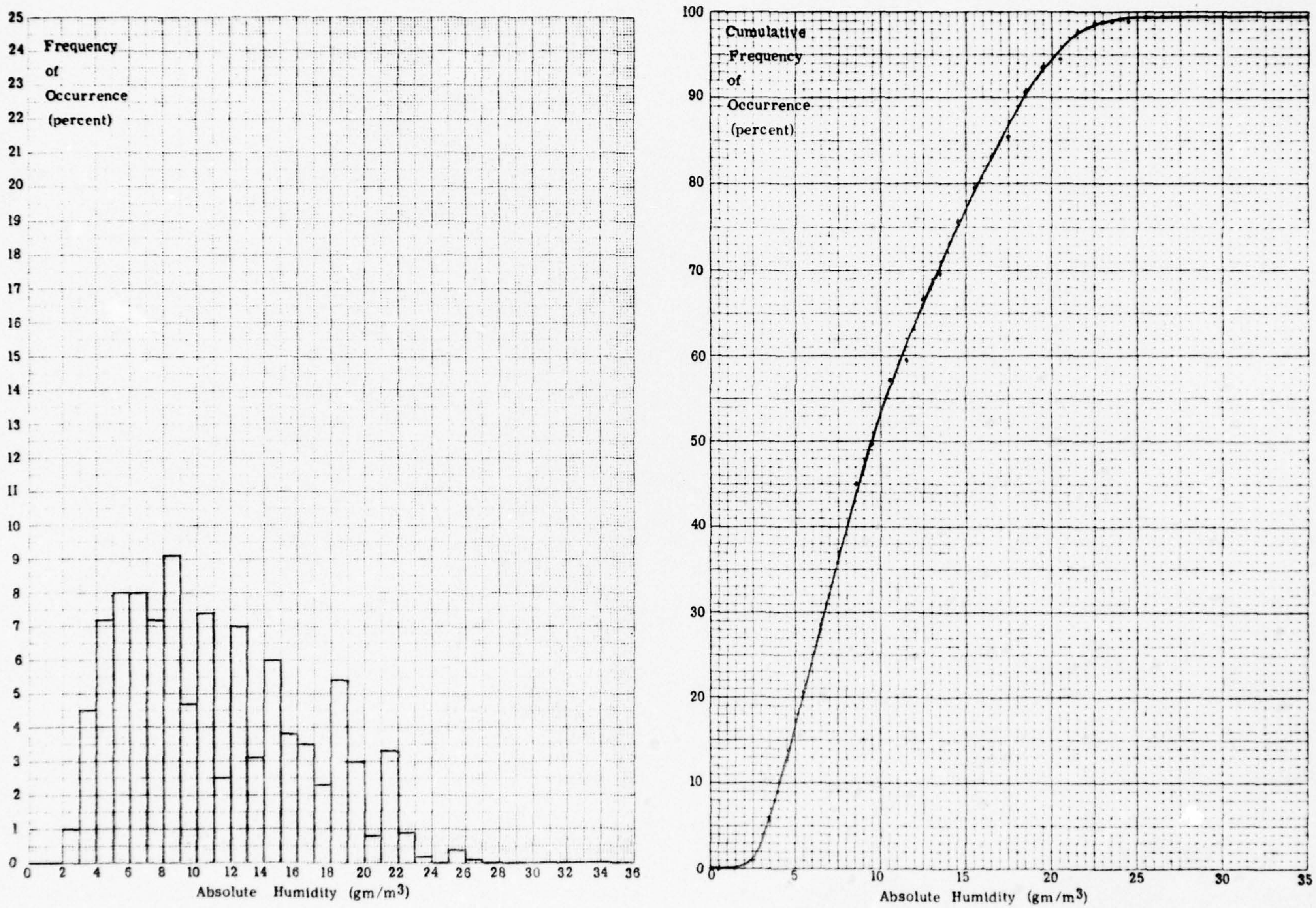


FIGURE 6. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - SAN FRANCISCO, CALIFORNIA

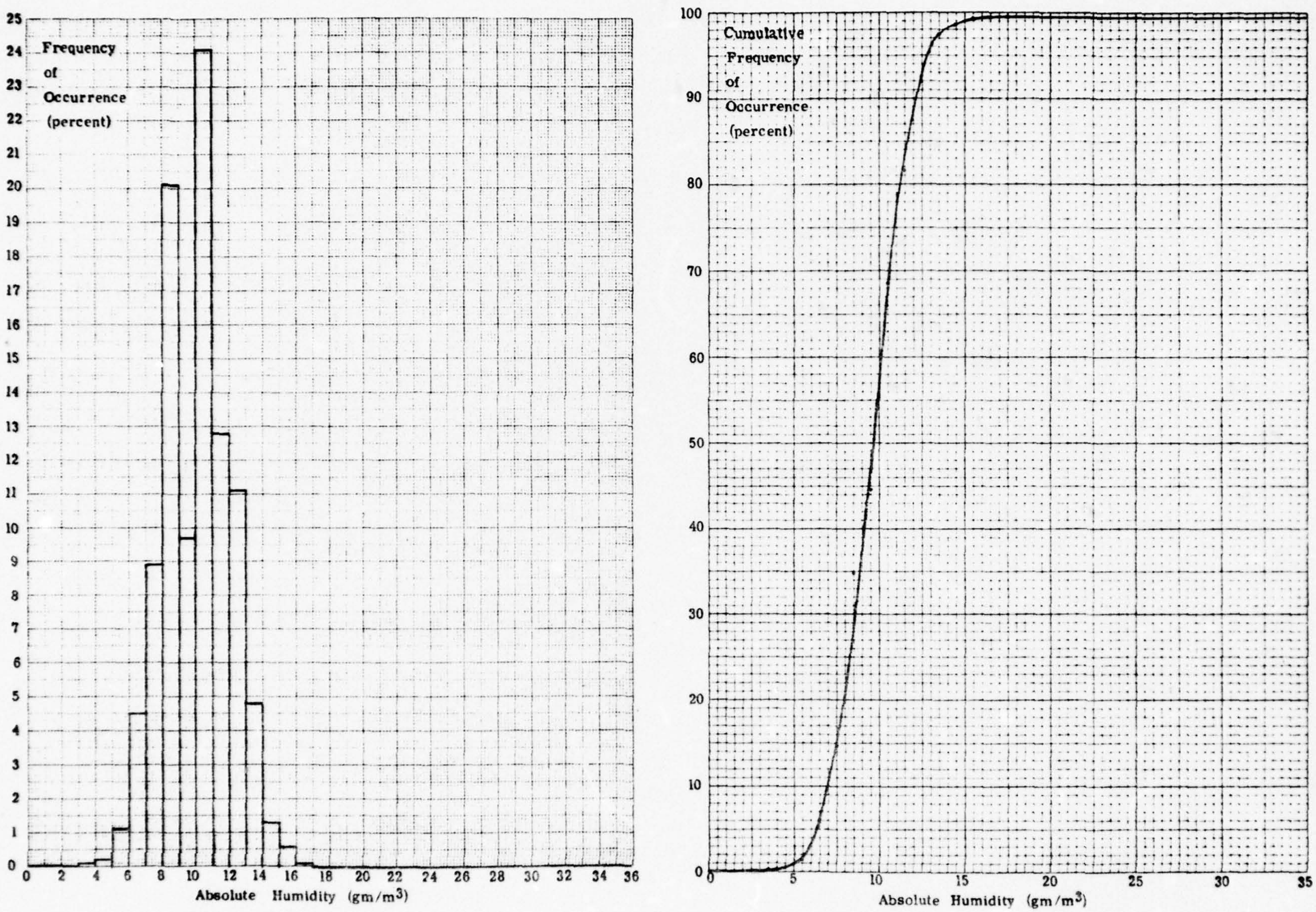


FIGURE 7. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - SOUTH AEGEAN SEA

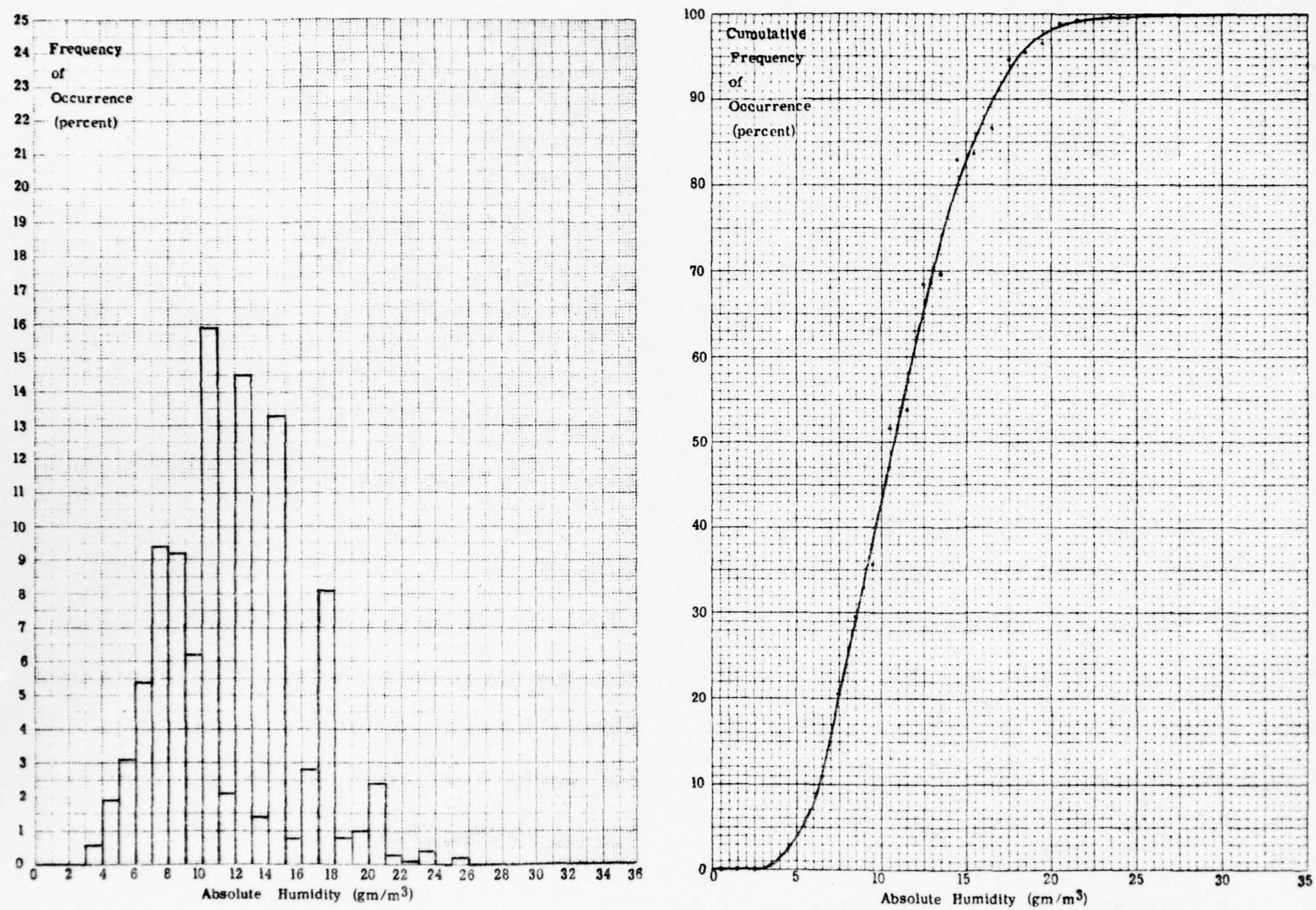


FIGURE 8. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - MALAGA, SPAIN

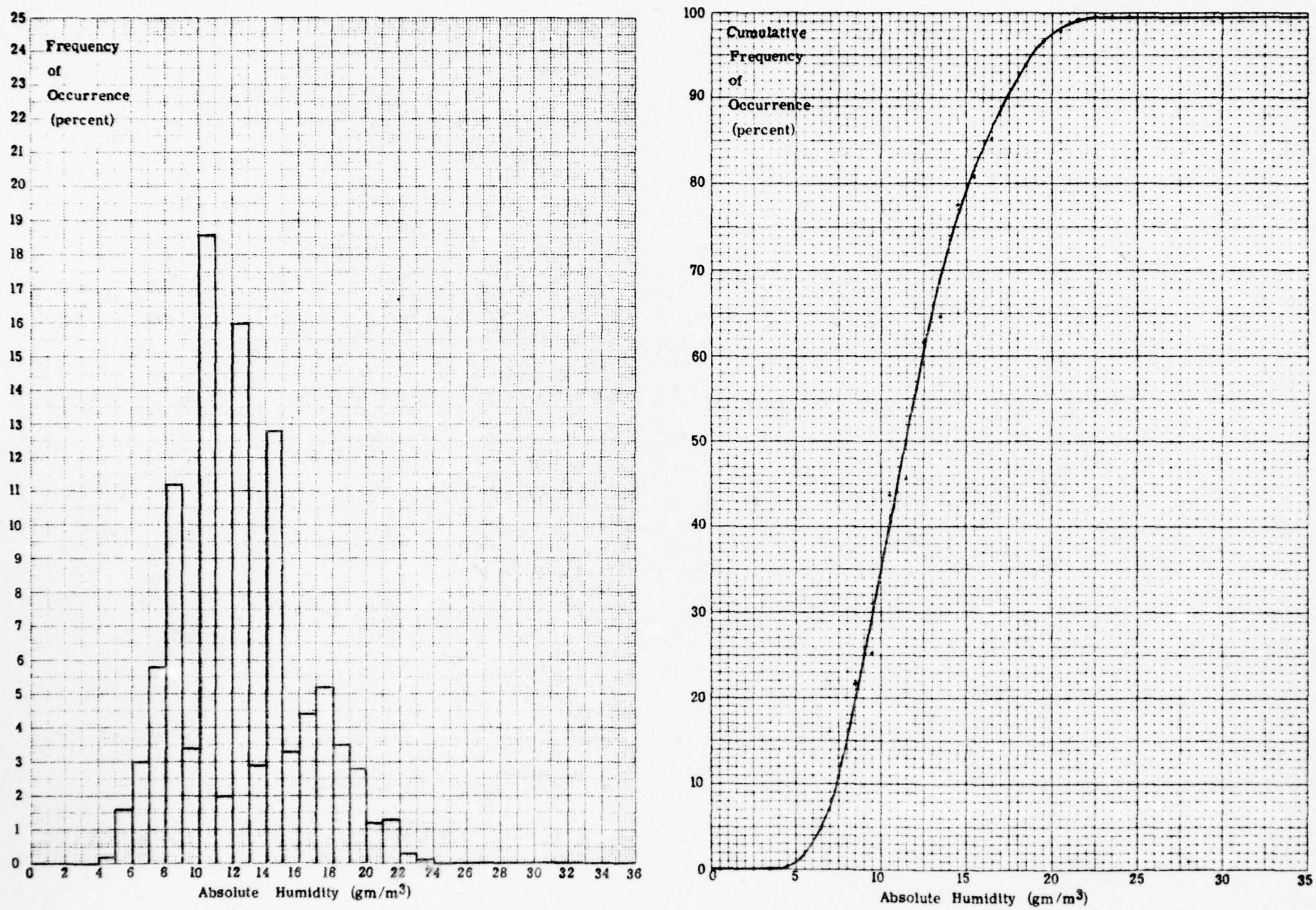


FIGURE 9. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - MATSUE, JAPAN

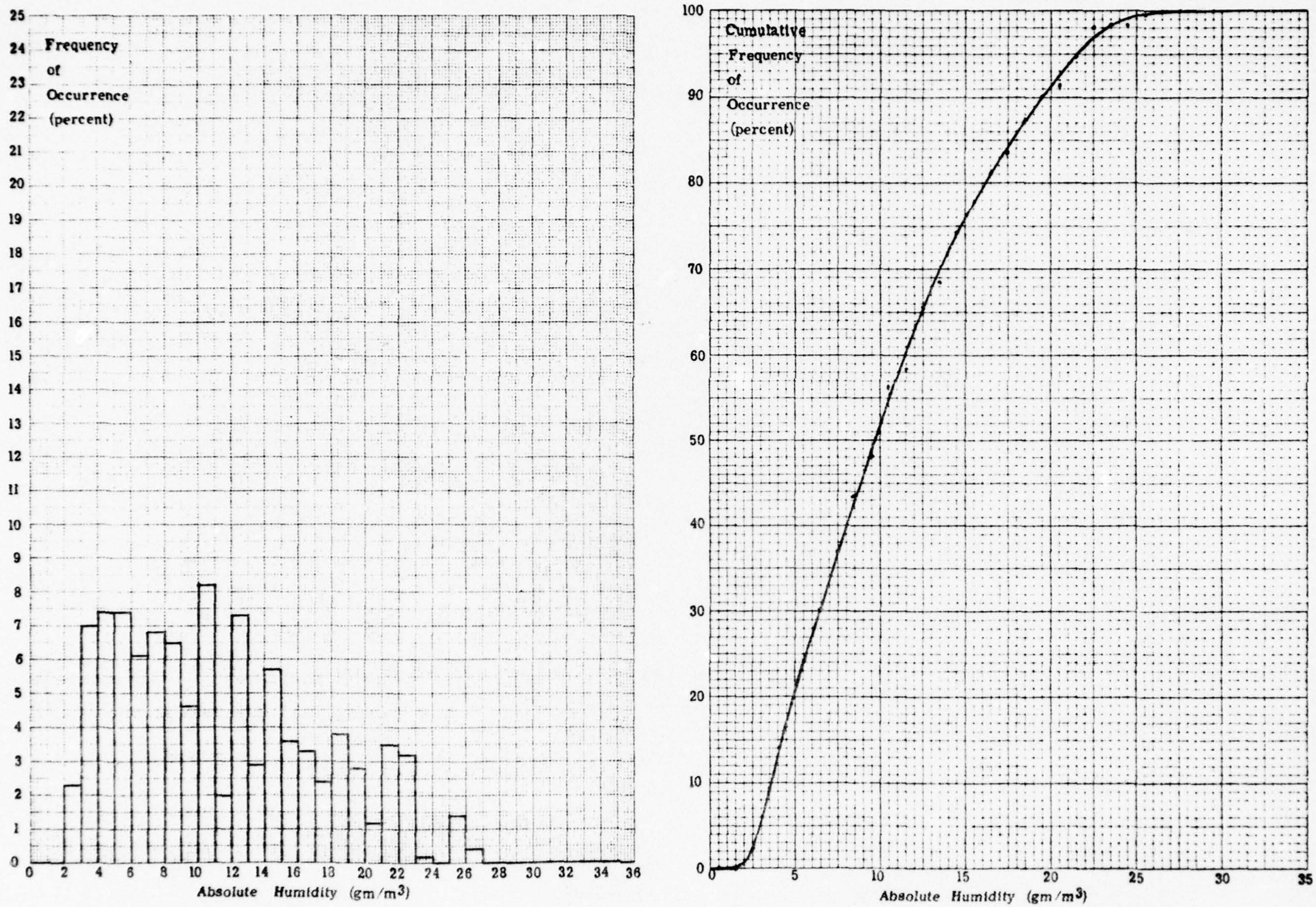


FIGURE 10. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - PORT SAID, EGYPT

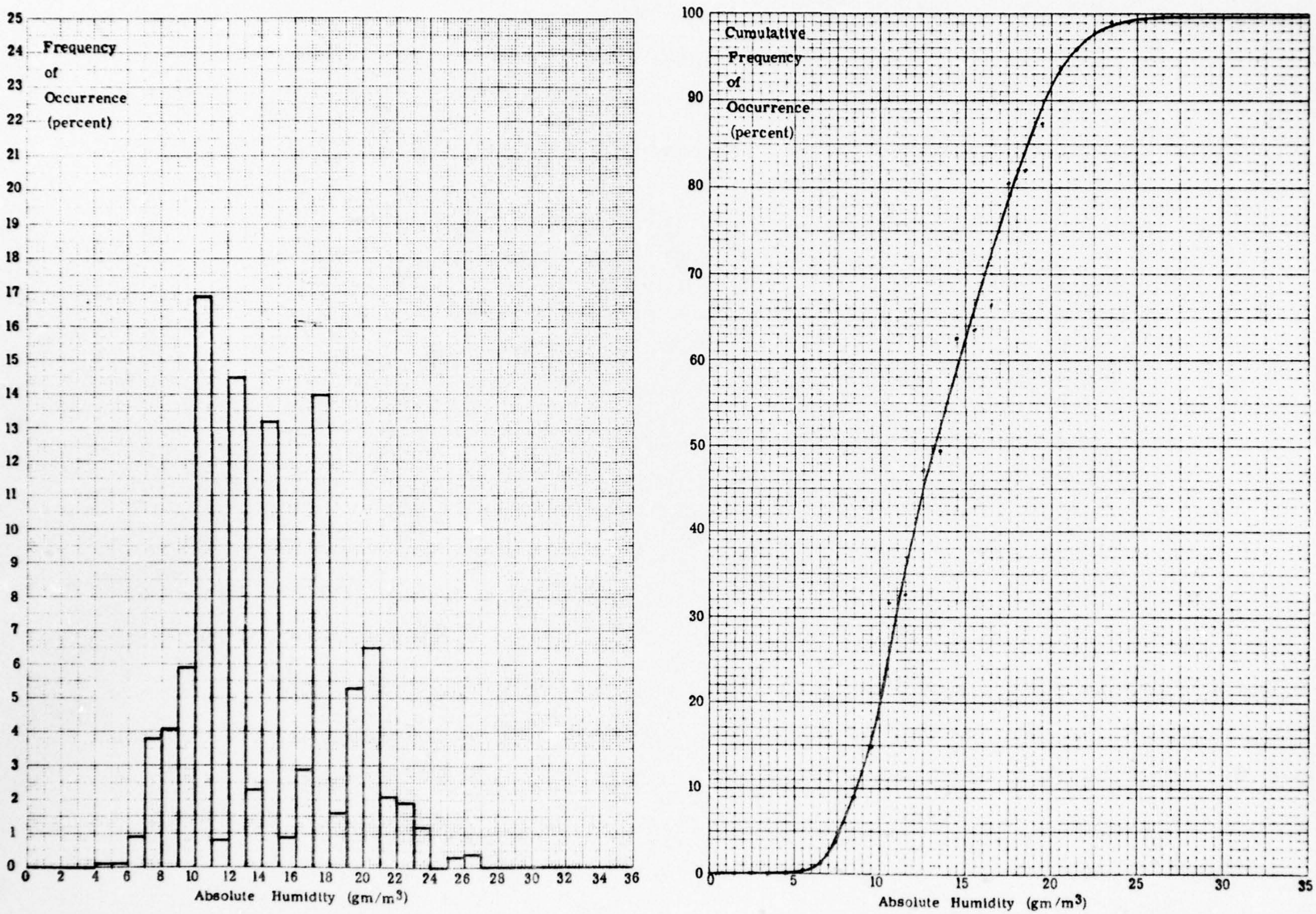


FIGURE 11. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - N. W. PERSIAN GULF

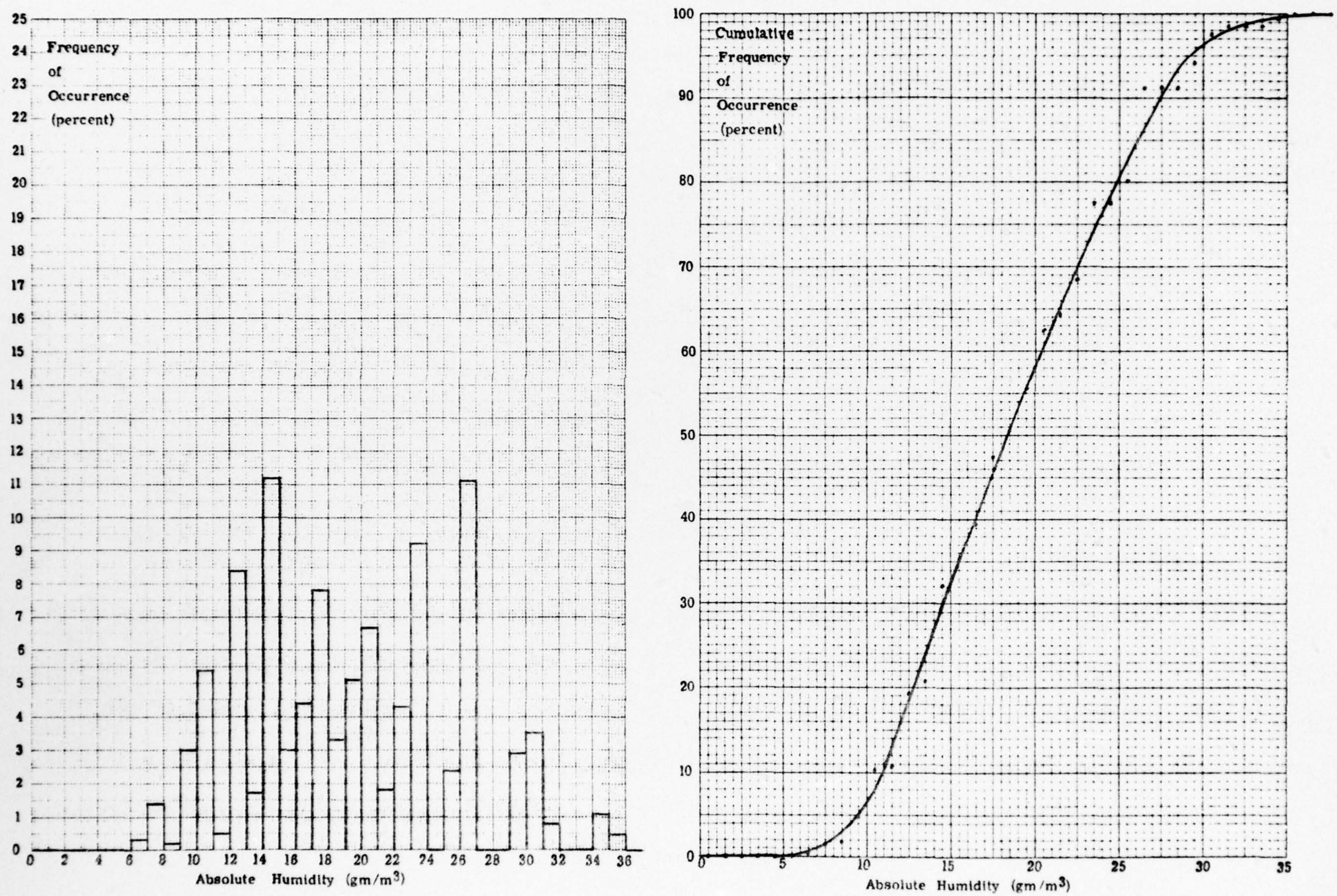
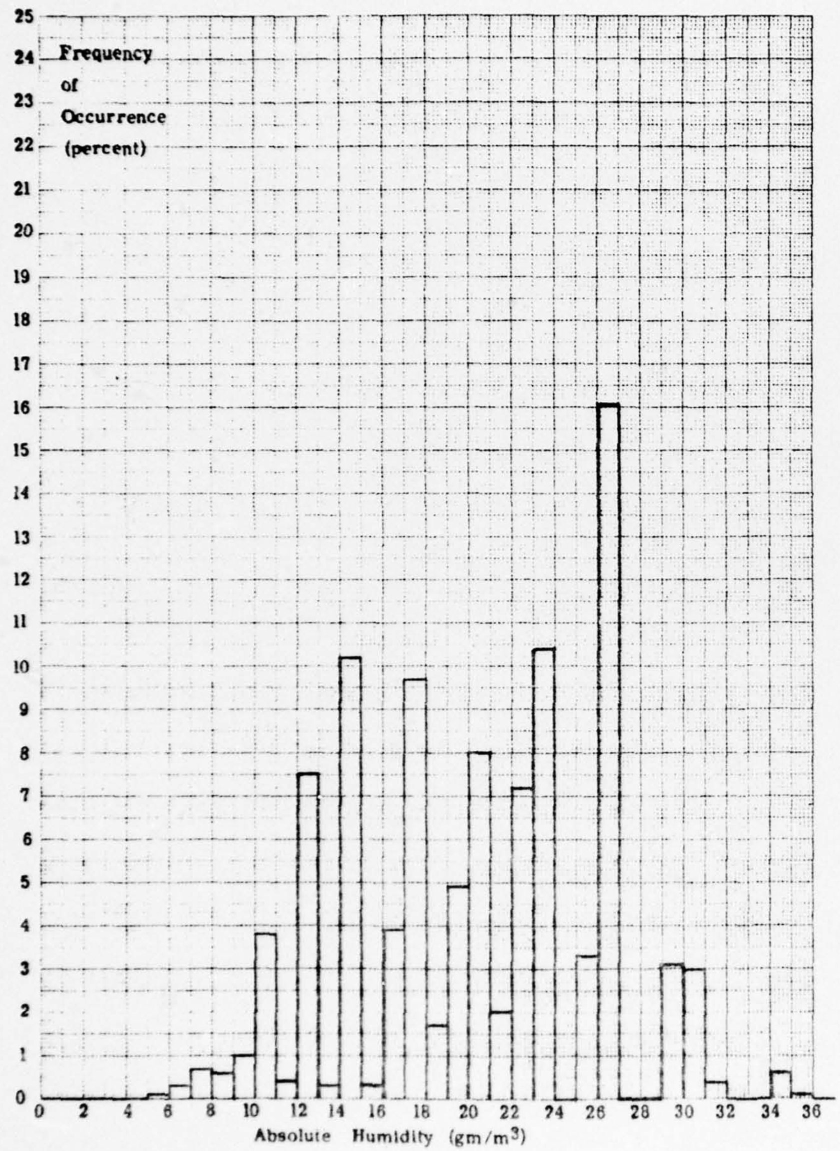


FIGURE 12. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - N. GULF OF OMAN



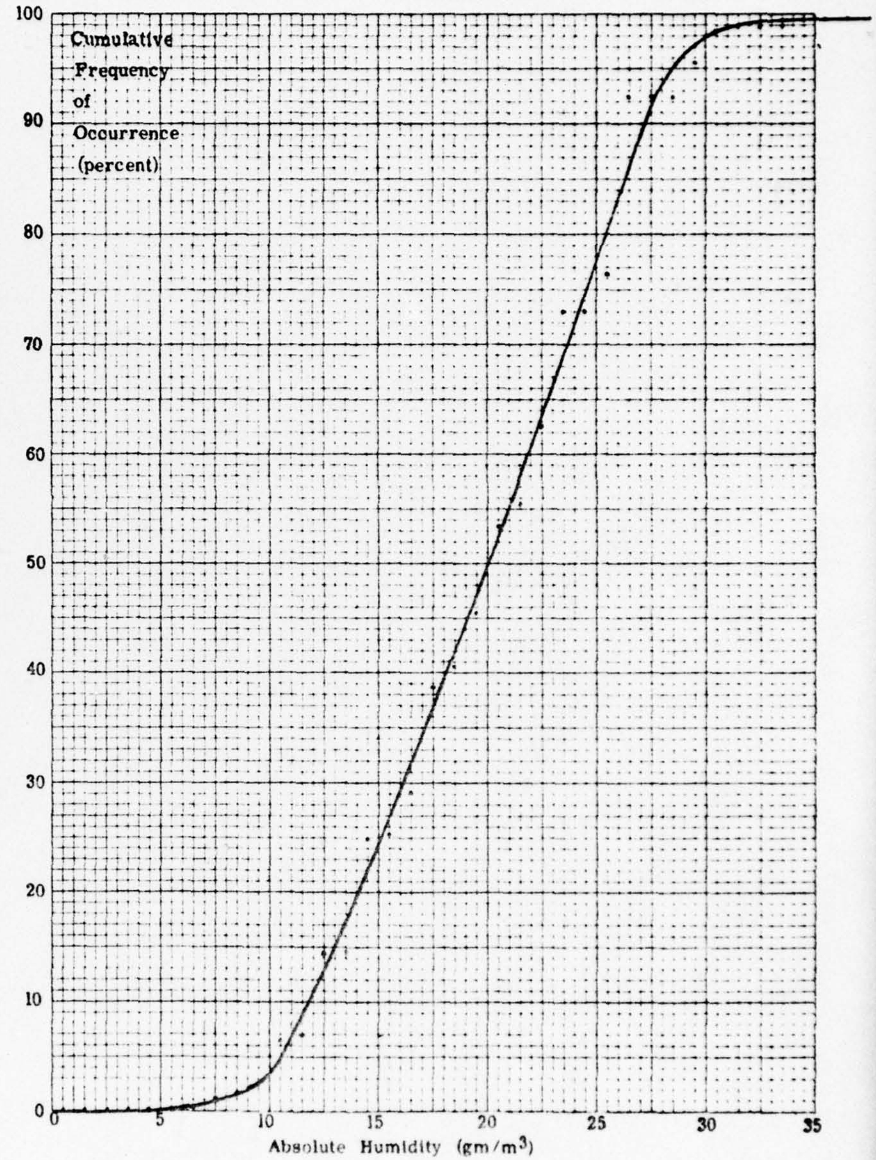
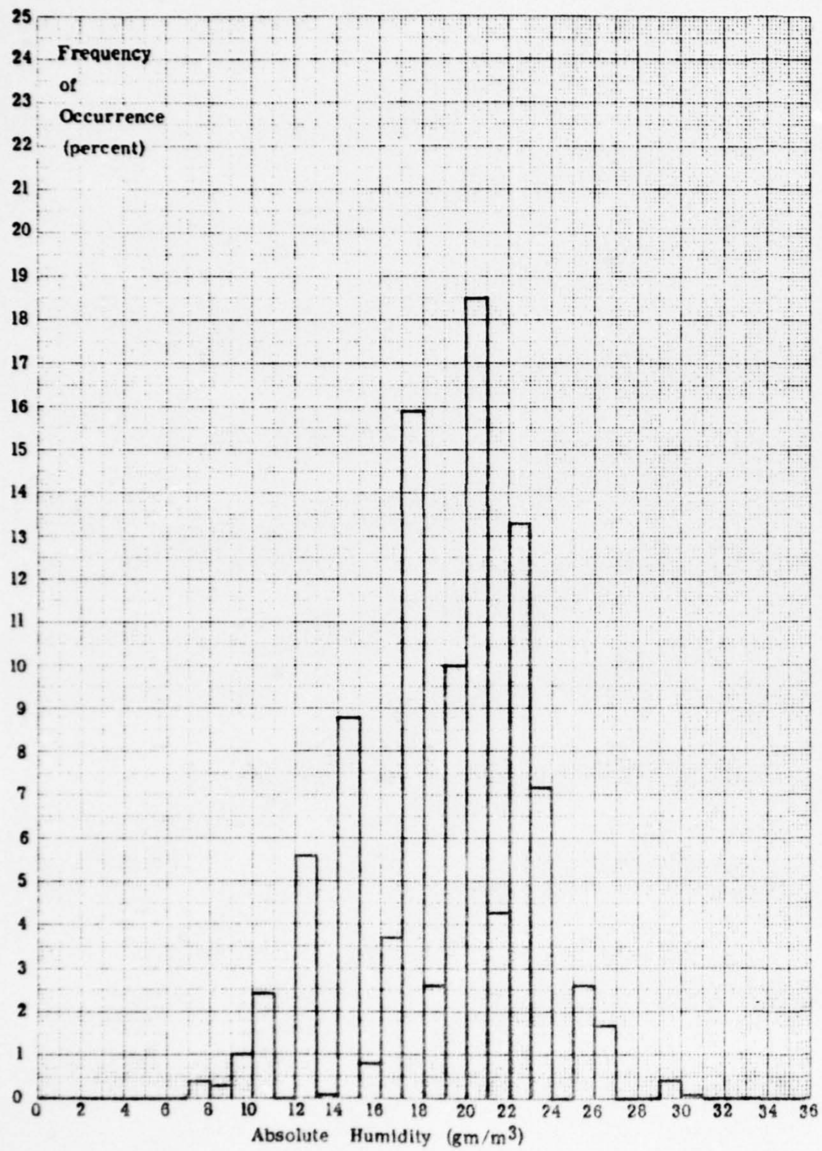



FIGURE 13. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - KEY WEST, FLORIDA



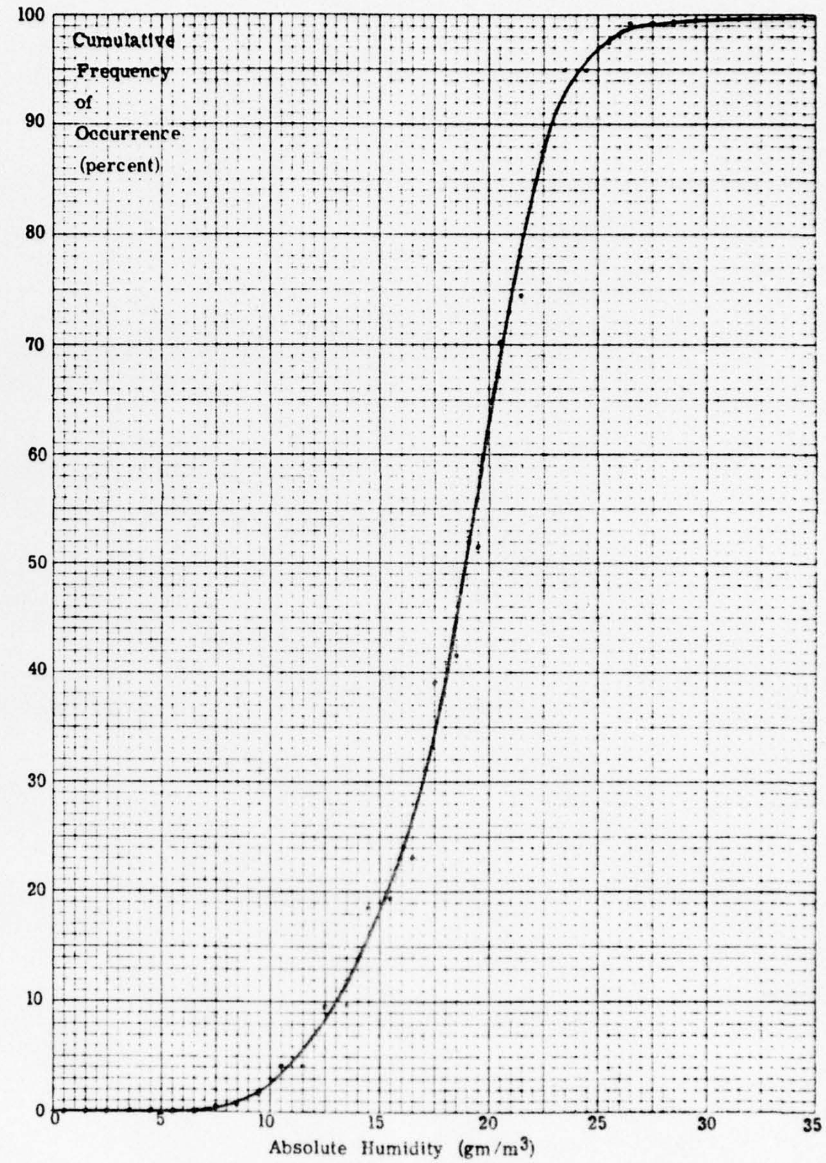
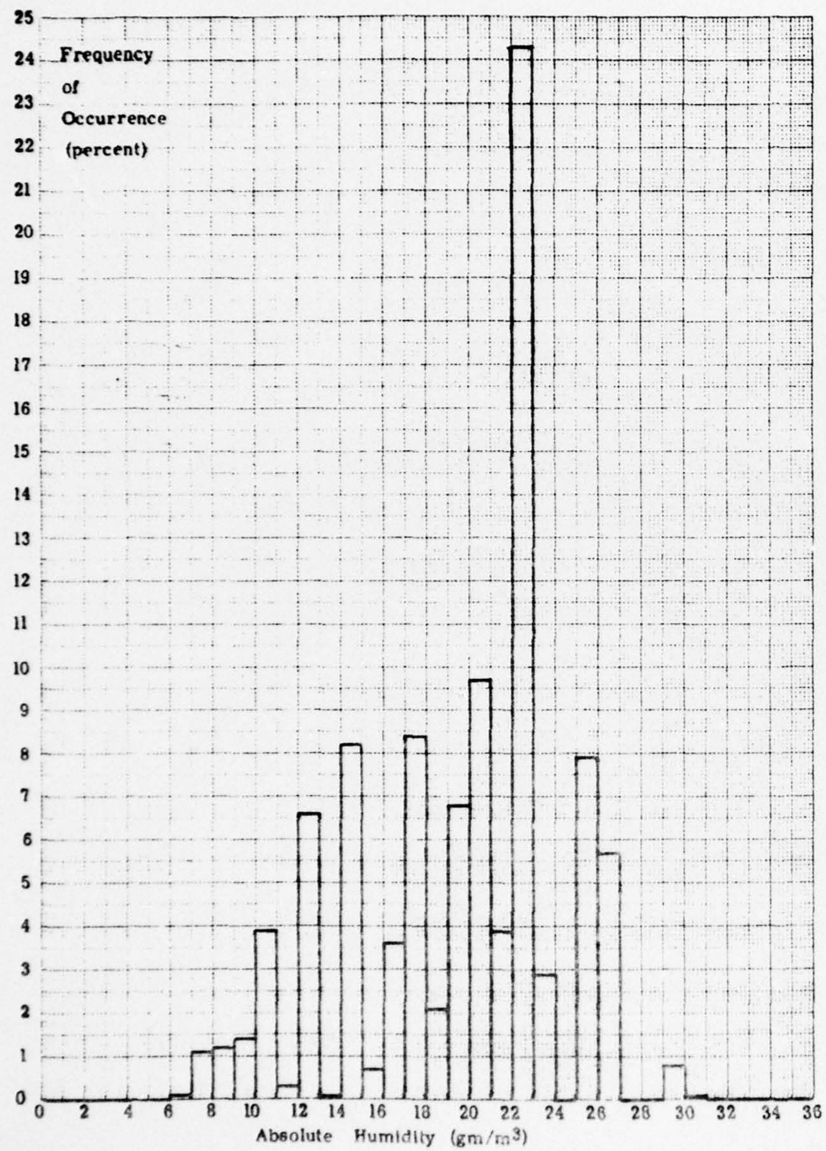



FIGURE 14. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - KARACHI, PAKISTAN



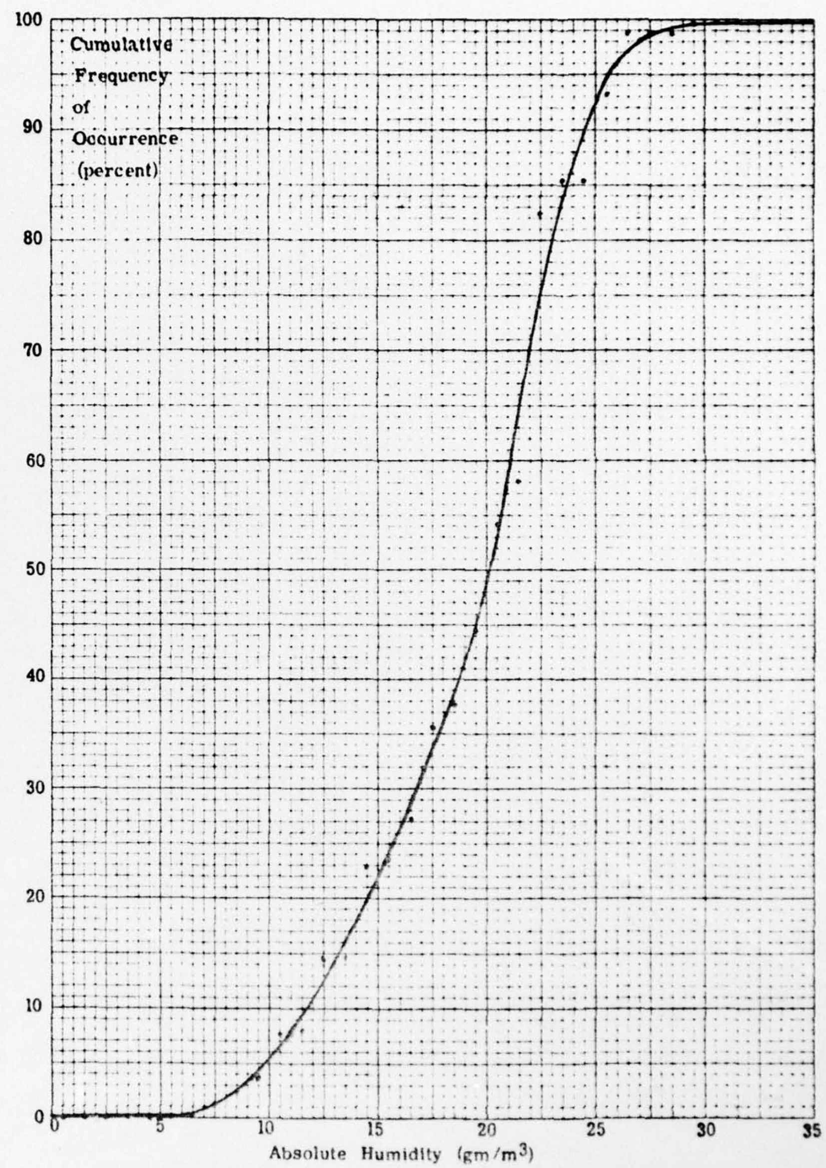
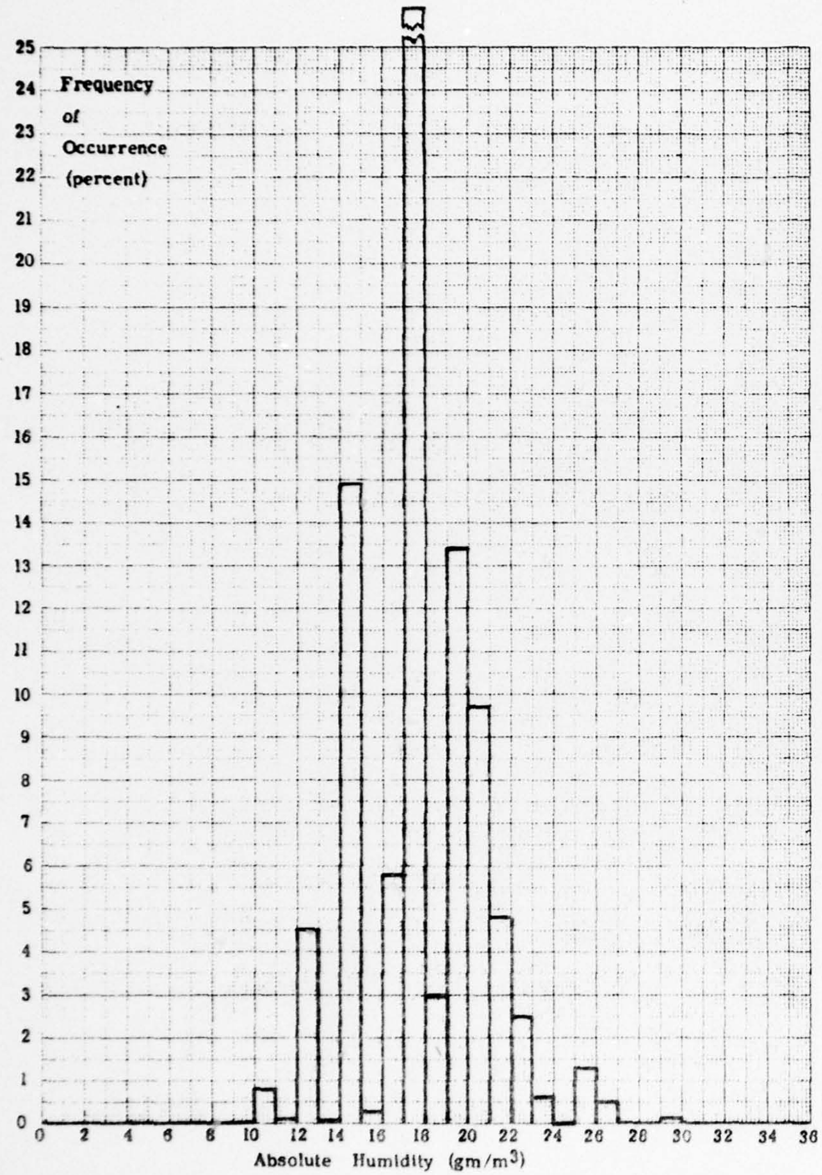



FIGURE 15. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - HAWAIIAN LEEWARD



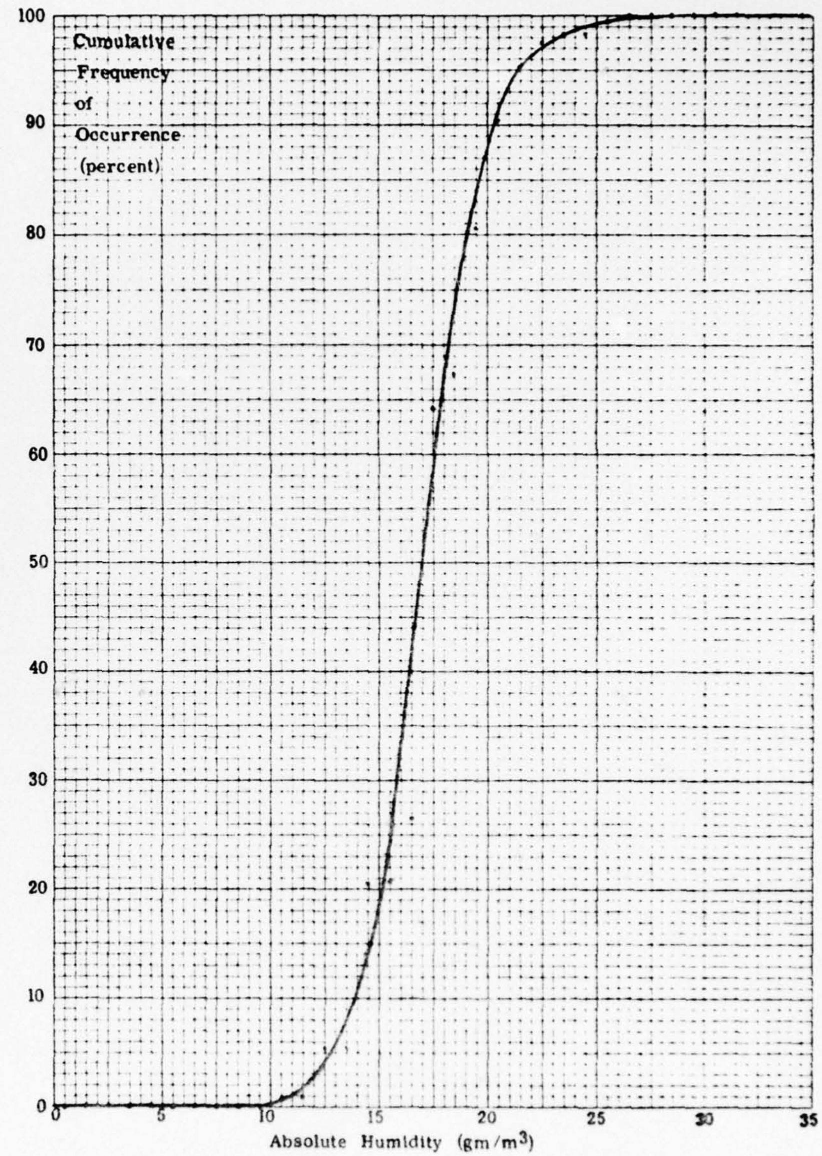



FIGURE 16. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - GUANTANAMO, CUBA

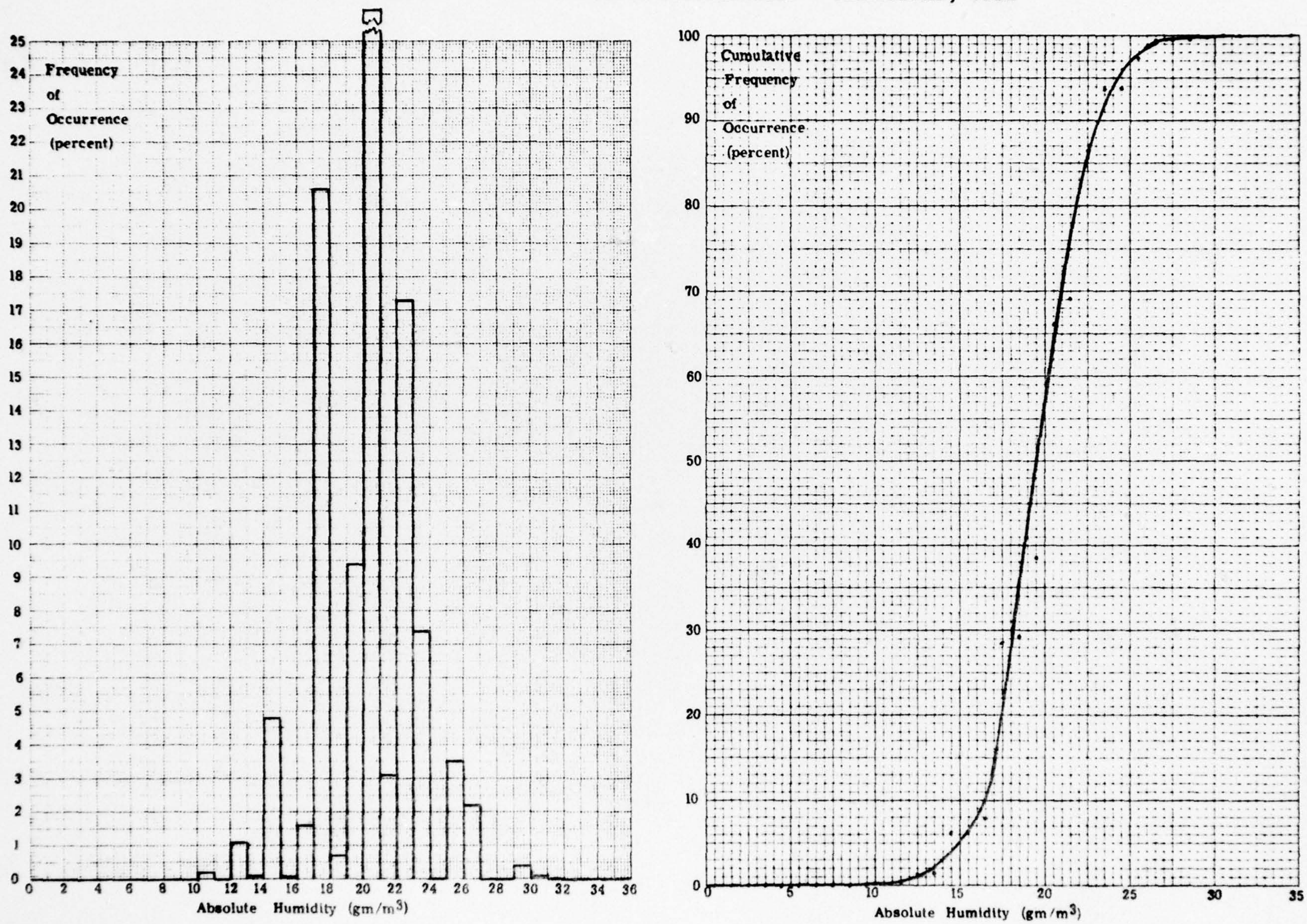
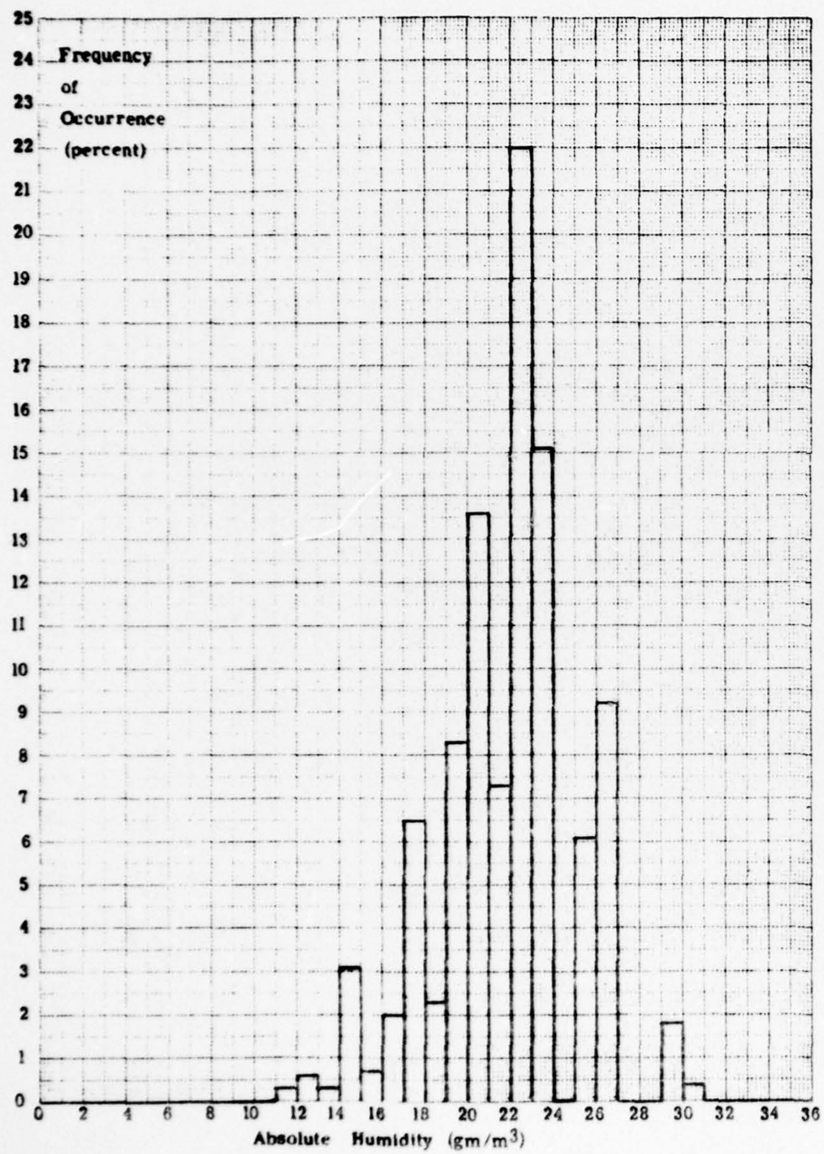


FIGURE 17. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - S. CHINA SEA AREA VII



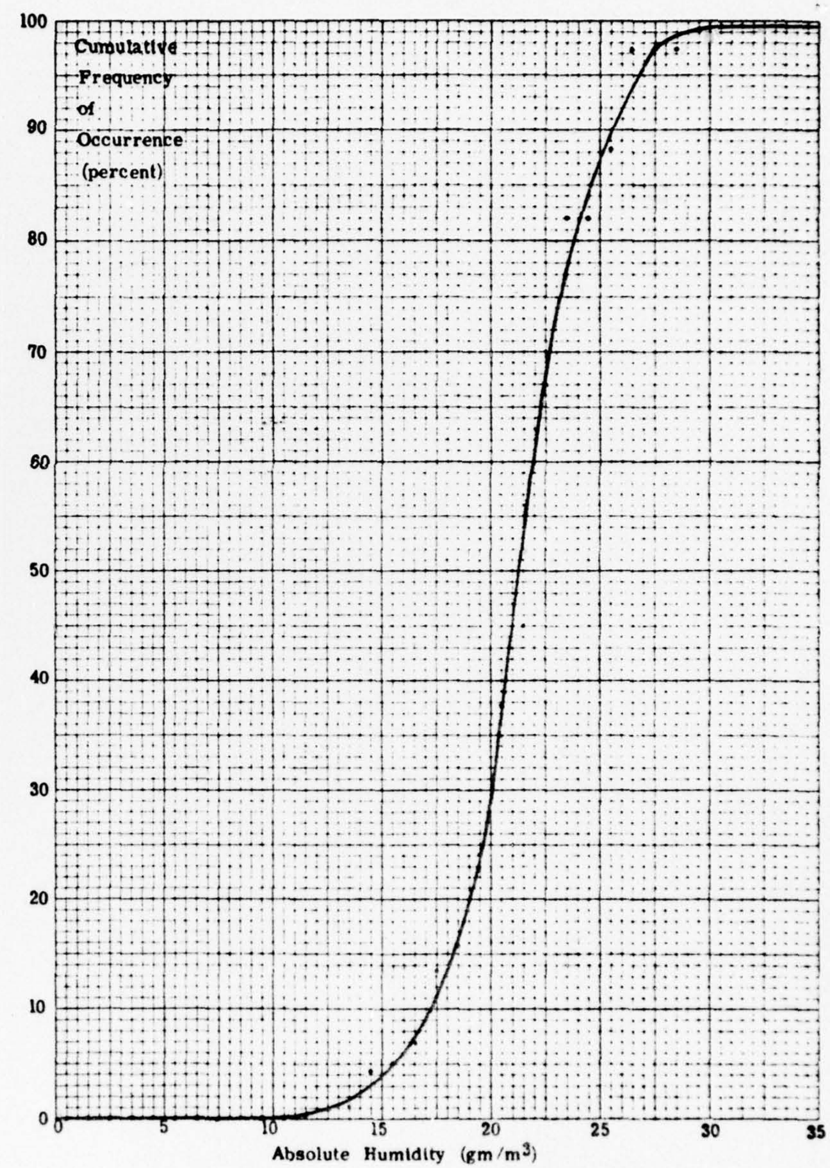



FIGURE 18. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - VISHAKHAPATNAM, INDIA

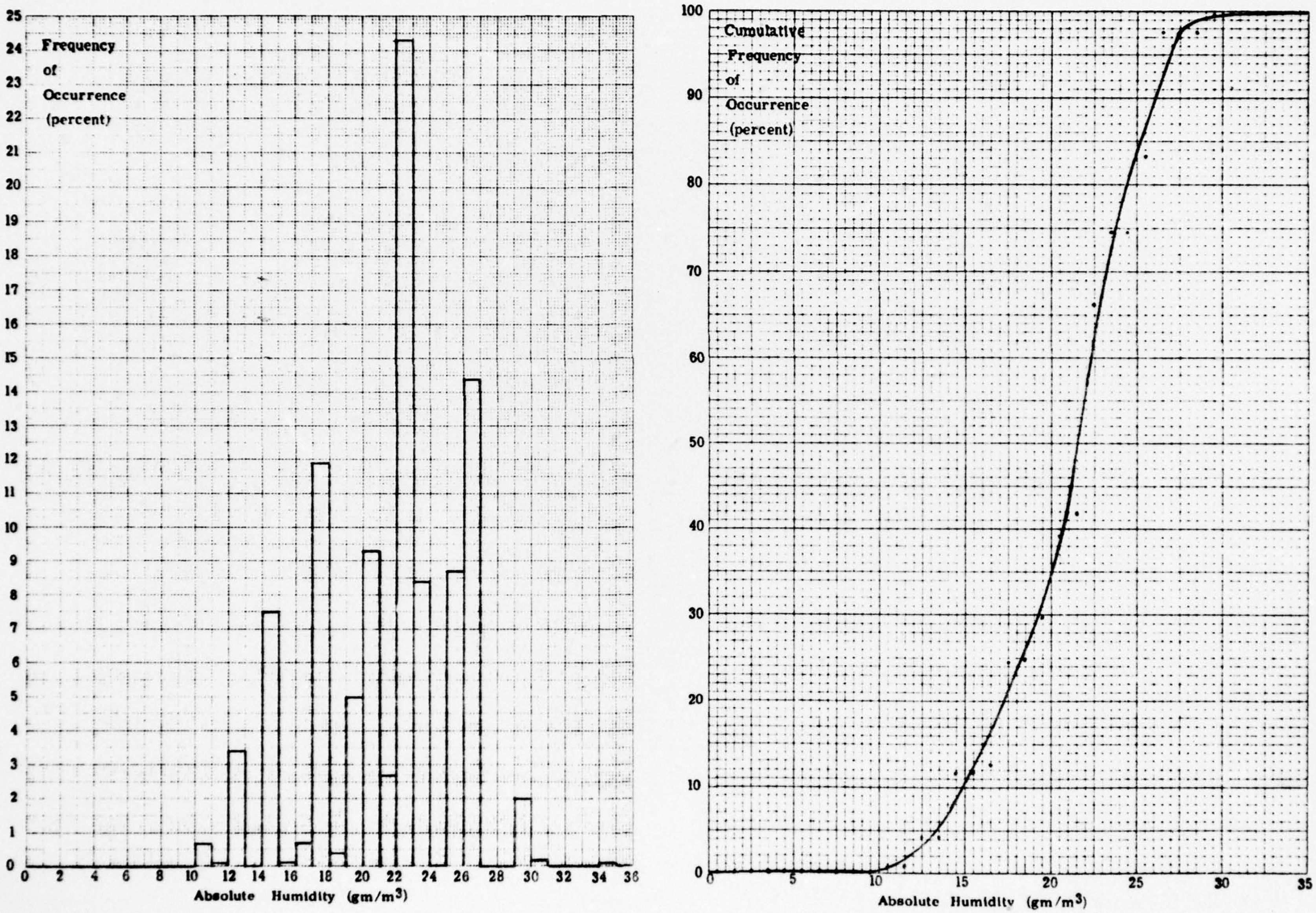
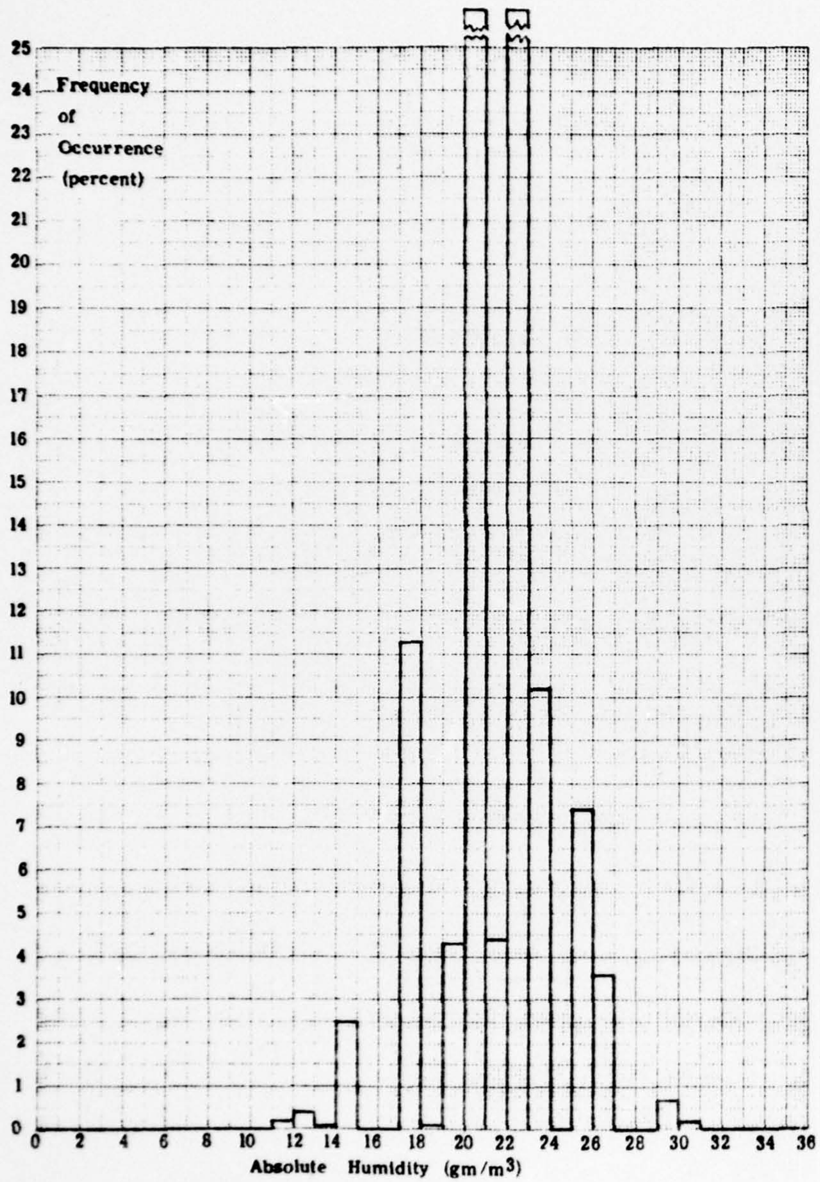


FIGURE 19. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - PANJIM, GOA



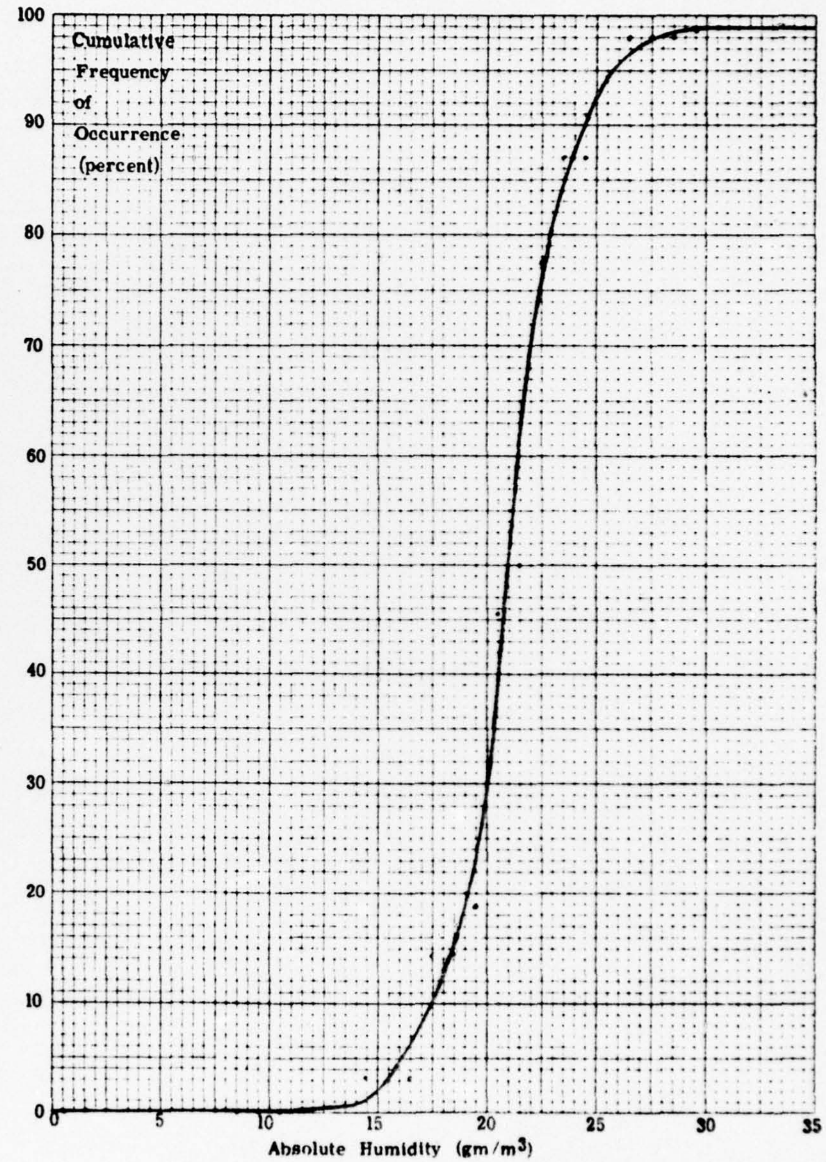
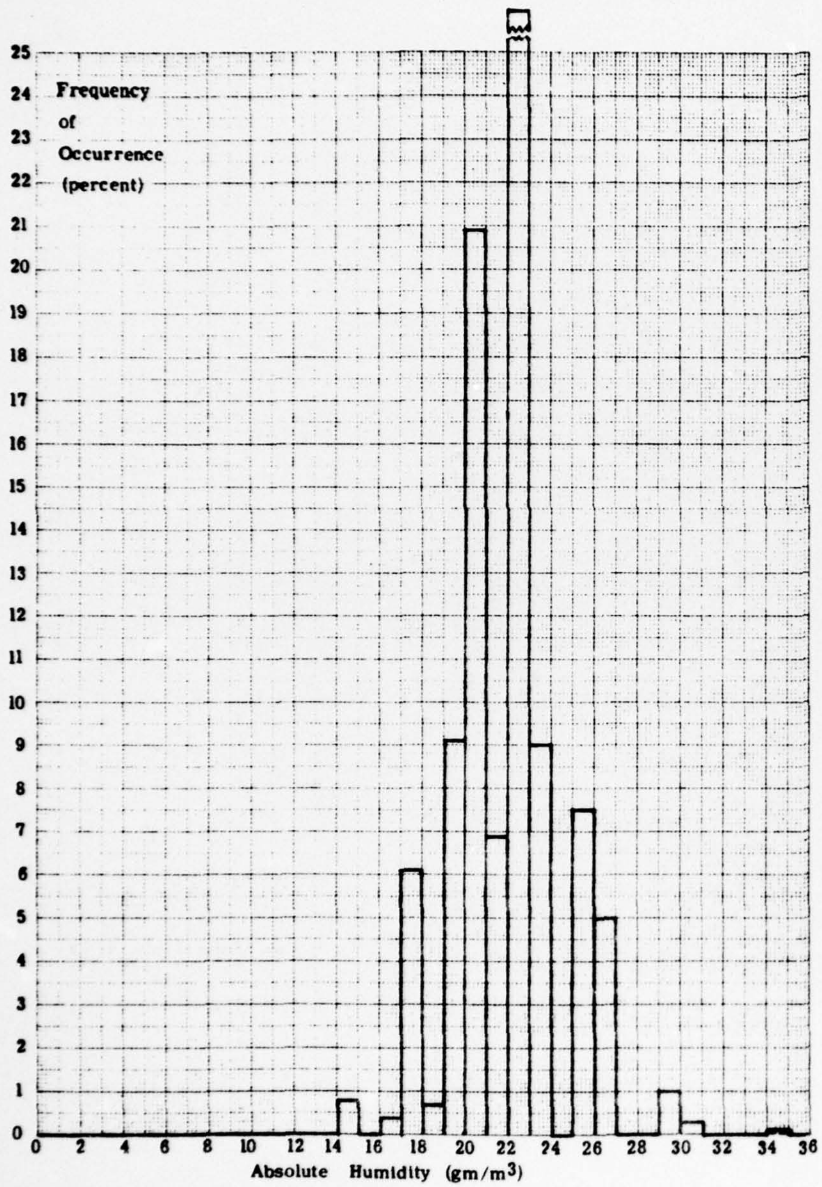



FIGURE 20. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - S. CHINA SEA AREA I



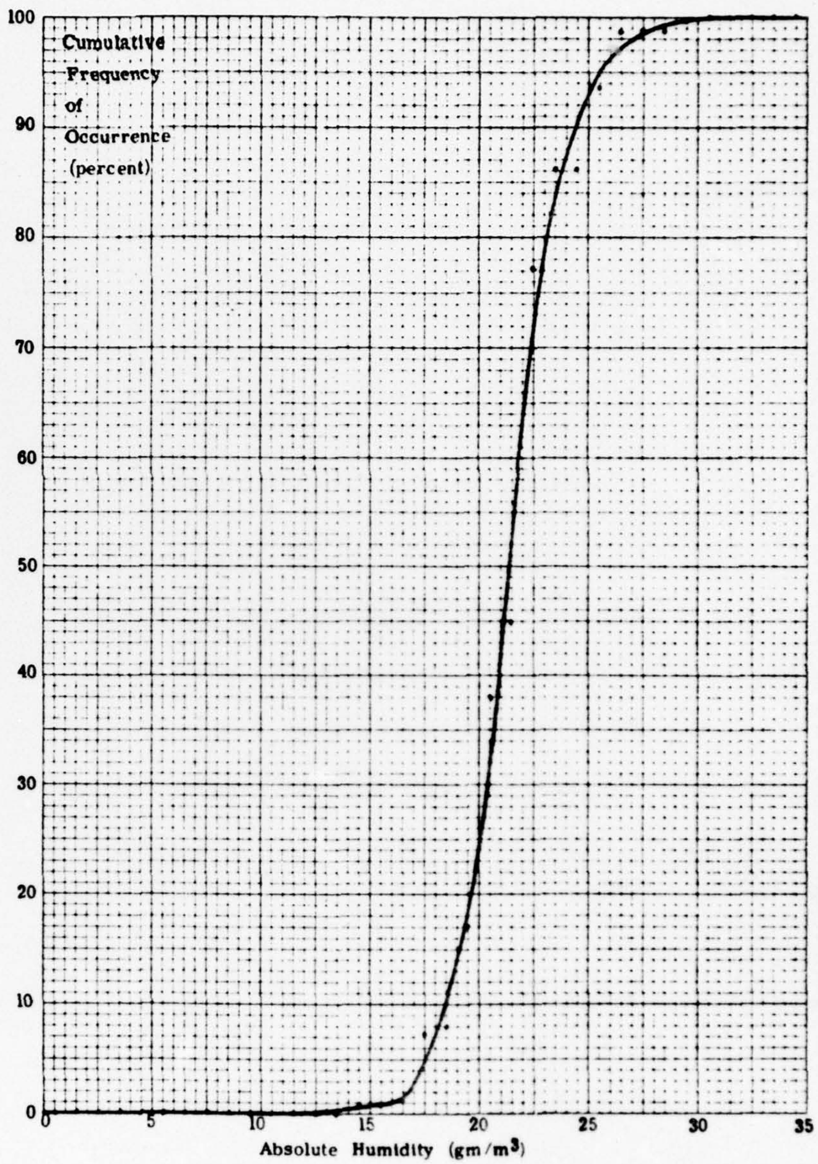
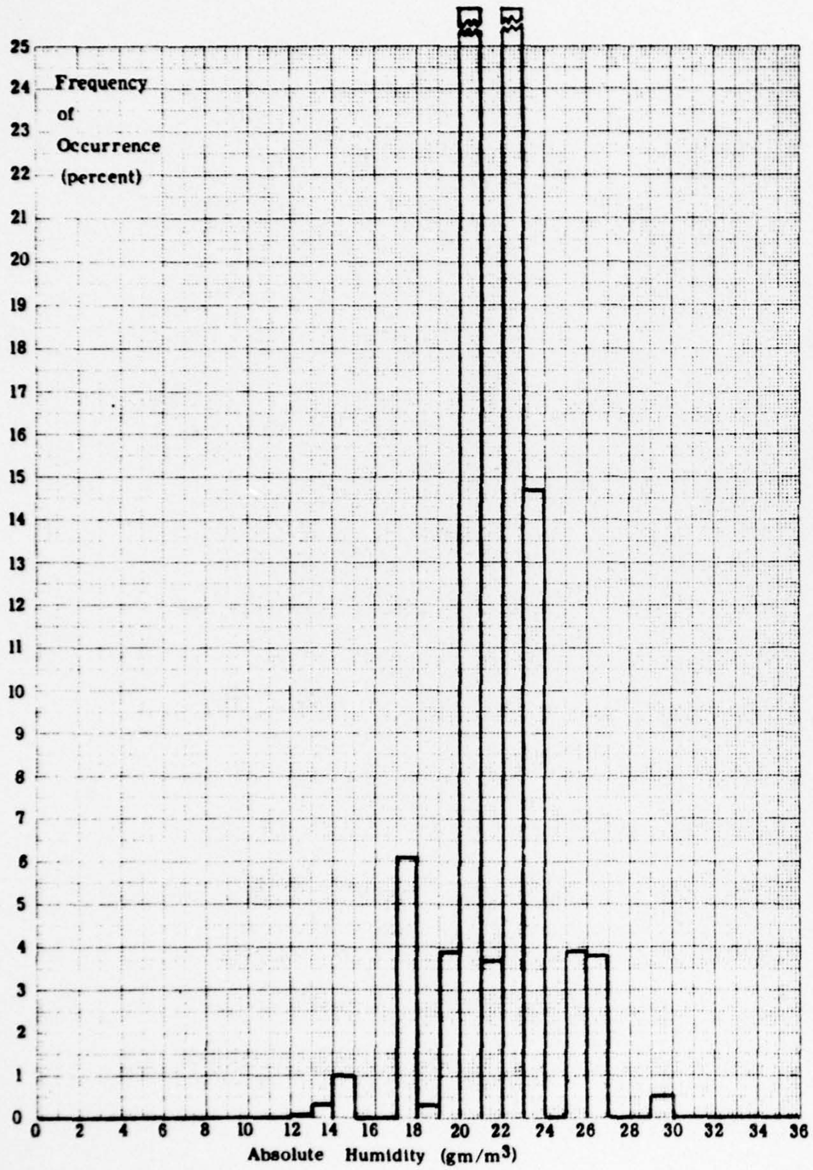



FIGURE 21. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - S. CHINA SEA AREA VI



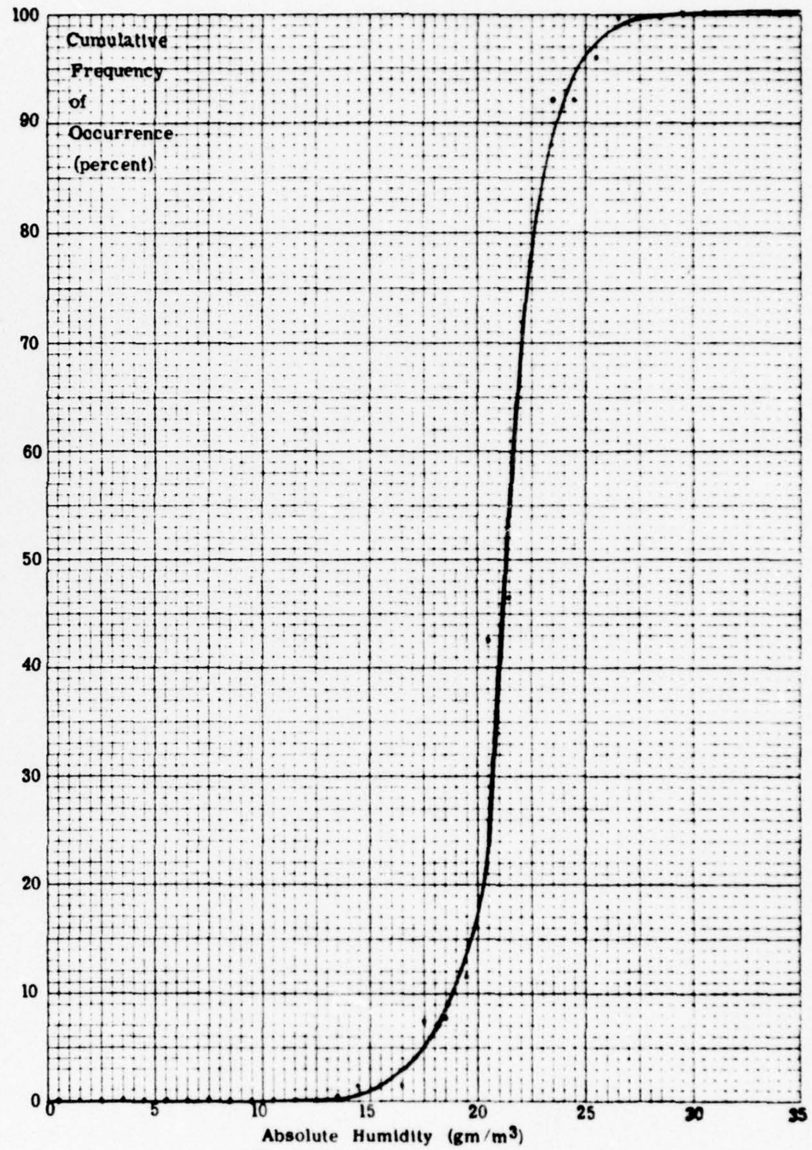
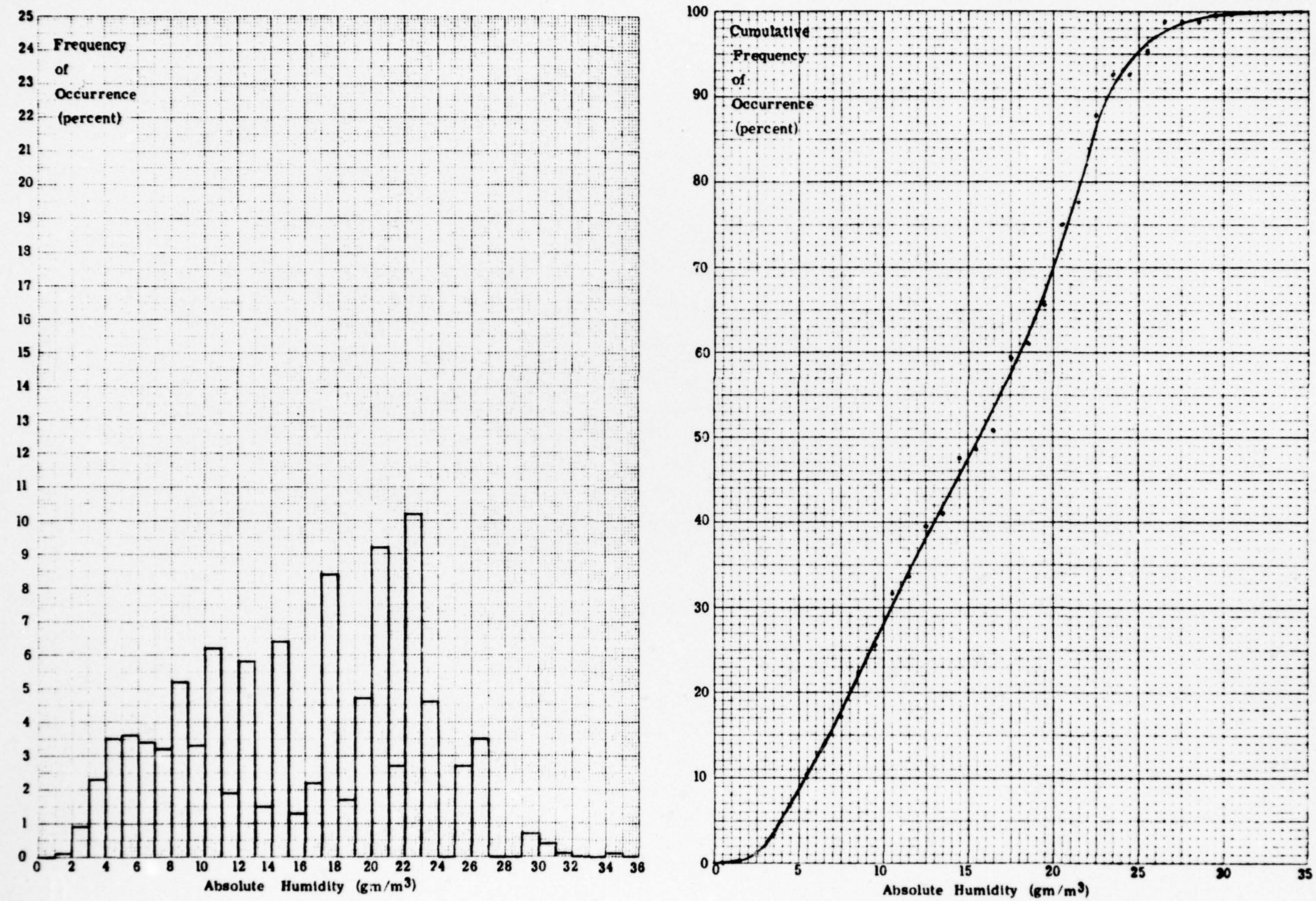



FIGURE 22. ANNUAL ABSOLUTE HUMIDITY DISTRIBUTION - COMPOSITE OF 21 SITES



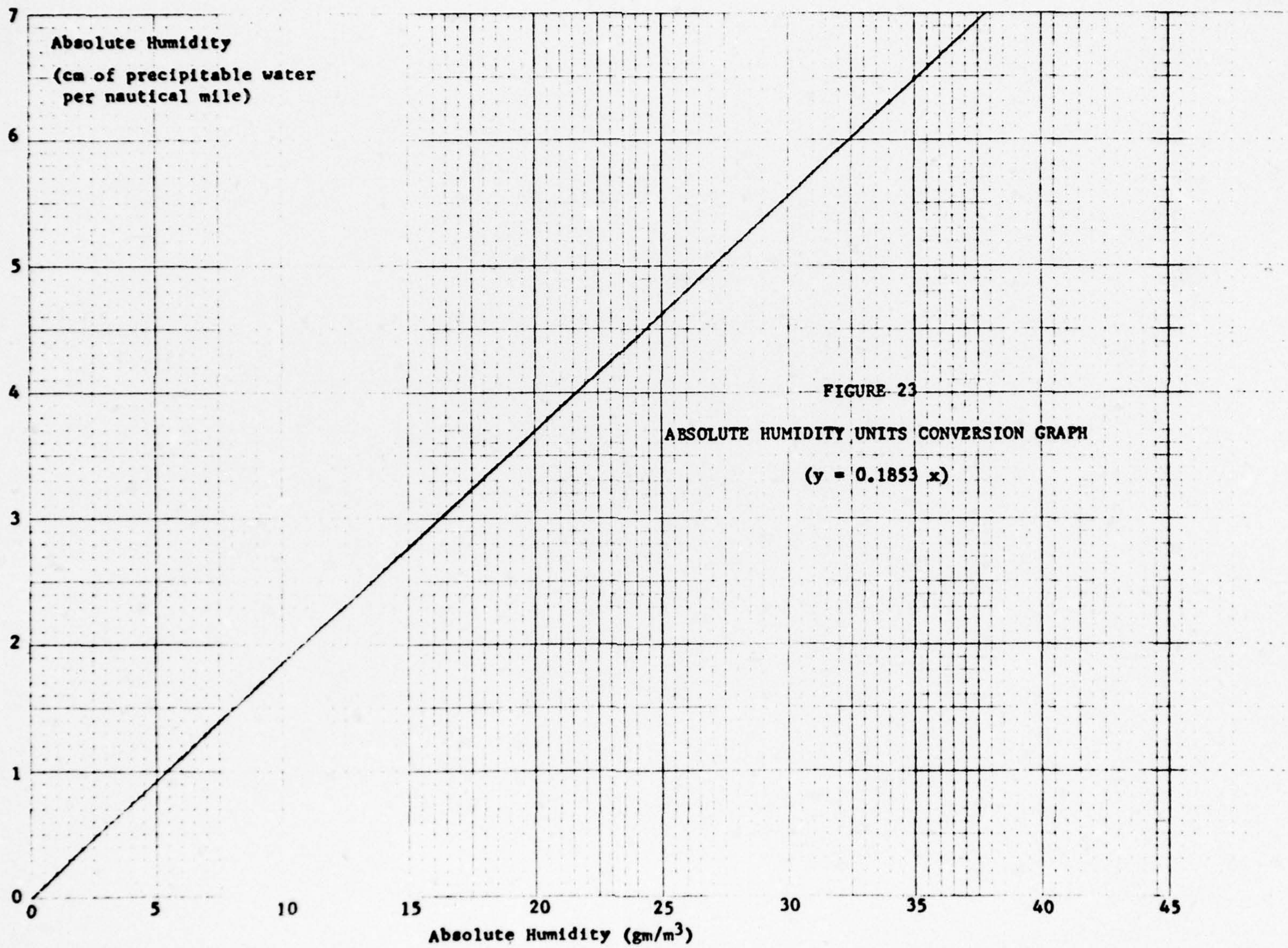



FIGURE 23

ABSOLUTE HUMIDITY UNITS CONVERSION GRAPH

($y = 0.1853\ x$)

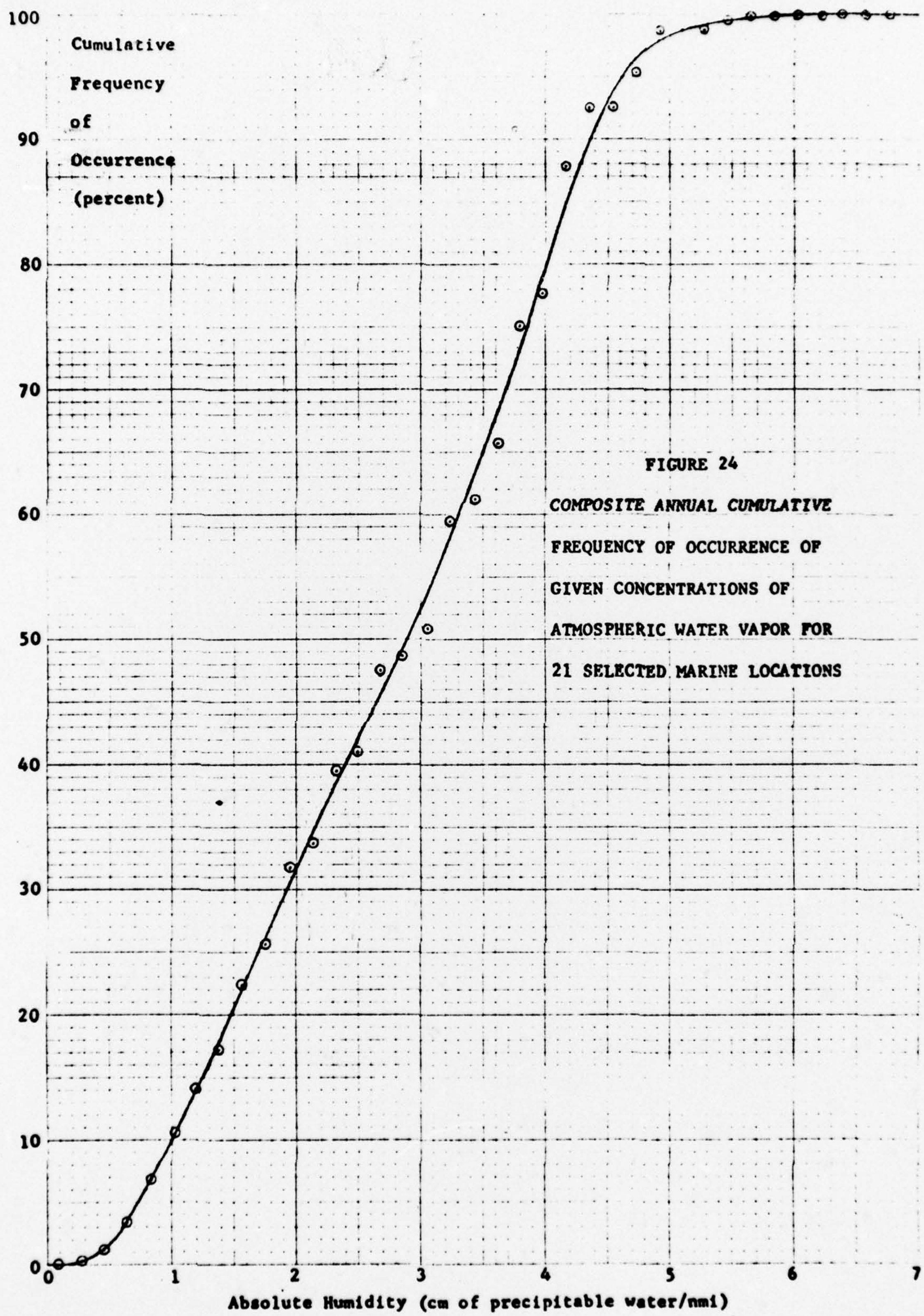



FIGURE 24

COMPOSITE ANNUAL CUMULATIVE FREQUENCY OF OCCURRENCE OF GIVEN CONCENTRATIONS OF ATMOSPHERIC WATER VAPOR FOR 21 SELECTED MARINE LOCATIONS